DOCUMENT RESUME

ED 355 937	IR 016 035
AUTHOR	Carey, Doris, Ed.; And Others
TITLE	Technology and Teacher Education Annual 1993. Proceedings of the Annual Conference on Technology and Teacher Education (4th, San Diego, California, March 17-20, 1993).
INSTITUTION	Association for the Advancement of Computing in Education, Charlottesville, VA.; Society for Technology and Teacher Education, Greenville, NC.
REPORT NO	ISBN-1-880094-05-3
PUB DATE	93
NOTE	767p.; For 1992 conference proceedings, see ED 343 581.
AVAILABLE FROM	Association for the Advancement of Computing in Education, P.O. Box 2966, Charlottesville, VA 22902 ($45).
PUB TYPE	Collected Works - Conference Proceedings (021)
EDRS PRICE	MF04/PC31 Plus Postage.
DESCRIPTORS	Computer Simulation; Cultural Differences; Educational Research; *Educational Technology; *Elementary School Teachers; Elementary Secondary Education; Graduate Study; Higher Education; Instructional Design; Mathematics Education; Methods Courses; Multicultural Education; *Multimedia Instruction; Research Projects; Science Education; *Secondary School Teachers; *Teacher Education; Teacher Role; Technological Advancement; *Telecommunications
IDENTIFIERS	Diversity (Student); Office of Technology Assessment

ABSTRACT

Papers from the fourth annual conference on Technology and Teacher Education are presented. The keynote address, "Teaching Matters: The Role of Technology in Education" (K. Fulton) explores some of the key findings of educational technology studies conducted by the Office of Technology Assessment over the last five years. Conference sections and the number of papers delivered for each are as follows: (1) Diversity, 9 papers; (2) Inservice and Graduate Education, 14 papers; (3) Integrating Technology into Methods Classes, 4 papers; (4) Instructional Technology, 5 papers; (5) Multimedia, 11 papers; (6) Concepts and Procedures, 10 papers; (7) Technology Diffusion, 17 papers; (8) Preservice Teacher Education, 19 papers; (9) Instructional Design, 11 papers; (10) Research Section 1, 5 papers; (11) Research Section 2, 16 papers; (12) Mathematics and Science, 11 papers; (13) Telecommunications, 23 papers; and (14) Simulations, 4 papers. Most of the papers include references. (SLD)

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Society for Technology and Teacher Education

Technology and Teacher Education Annual 1993

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Technology and Teacher Education Annual

—1993—

Published for the Society for Technology and Teacher Education
by
Association for the Advancement of Computing in Education
Post Office Box 2966
Charlottesville, VA 22902 USA
(804) 973-3987; FAX (804) 978-7449;
E-mail: AACE@VIRGINIA.EDU

ISBN 1-880094-05-3

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Published by the Association for the Advancement of Computing in Education (AACE)
P.O. Box 2966, Charlottesville, VA 22902 USA

Printed in the USA

Contents

Keynote Address
Teaching matters: The role of technology in education
Kathleen Fulton 1

Diversity **7**

The politics of technology in education and the role of Tteacher educators
Brent Robinson 9

Technology and diversity: Resolving computer equity issues through multicultural education
Rosemary W. Skeele 14

Where are the girls? Increasing female participation in computer, math, and science education
Deirdre Armitage 19

Technology and language minority students: Implications for teacher education
Nancy P. Hunt & Robert H. Pritchard 25

Anxiety, confidence, and attitudes toward computers among limited English proficient middle school students: Implications for teacher educators
Roy M. Bohlin, Carol Fry Bohlin, & Otto E. Benavides 28

Multimedia personal Computer based second language acquisition: New fantasy or old vision?
Dennis Michael Nulman 32

Using multimedia to teach social foundations in an urban teacher preparation program
Anthony G. Picciano 36

Developing a multimedia social studies lesson
Mary Jane Ford, Frances Zink, & Sue Jackson 41

The role of technology in education in the NEW South Africa
Kenneth Clark, Alice Hosticka, & Lorenzo de Neuilly Rice 44

Inservice & Graduate Education **49**

The effect of coaching of the use of technology in middle school mathematics classrooms
Juanita V. Copley & Susan E. Williams 51

A collaborative inservice model for training teachers in advanced technologies
Neal Grandgenett & Robert Mortenson 55

Service technology training: Overview of Project ICIP
Christine M. Bahr, Stephanie L. Kenney, & Alonzo E. Hannaford 60

A field based inservice training system for educational technology staff development
Terry R. Smith & Kathryn A. Smith 65

Effects of teacher involvement in curriculum development on calculator instruction and students' mathematics achievement
Susan E. Williams, Juanita V. Copley, Shwu-Yong Huang, & Hersholt C. Waxman 69

AZTEC: An inservice technology lab for rural vocational/technological teachers
Gaye Luna, Tim Foster 74

Computing and technology: What an administrator needs to know
Patrick J. Casey 78

A learning organization on Long Island: Technology in teacher education as it relates to a fourth grade project and Peter Senge's work on learning organizations
Bette E. Schneiderman 83

Integrating technology into a teacher certification Master's Degree program
Nancy Roberts & Angeline Ferris 88

Infusing technology in the curriculum: Training school media specialists
Nancy I. Todd 92

Integrating technology into graduate teacher education
Randall Parker 96

Empowering technology and pedagogical innovation: A bar code grade recorder prototype
Kip Tellez & Robert Miller 99

Training inservice and preservice teachers about videodisc technology: Resources for trainers
Donna J. Baumbach, Mary Bird, & Sally Brewer 103

Image processing for teaching project: Innovative inservice education
R. Kolvoord 107

Integrating Technology into Methods Classes 111

Models of technology integration for special education personnel preparation programs
Dave L. Edyburn 113

Enhancing use of computer technology in an integrated reading/language arts methods class
Michael P. French, Ann Polzer Landretti, & Daniel J. Tutolo 117

Hypertext portfolios: A new approach to teaching reading diagnosis
Michael C. McKenna & Kenneth F. Clark 122

The Earthquake Club: A model for integrating technology across the curriculum
Jeffrey W. Bauer & Guy M. Westhoff 125

Instructional Technology 128

The development and implementation of an instructional computing program for preservice teachers
Ann Thompson, Denise Schmidt, & Neal Topp 130

An educational media course: Merging theory, technique, and application
Jan Koppelman 133

Two studies: Attitude change during a required computer education course for preservice teachers
Gregg Brownell, Nancy Brownell, & Dieter Zirkler 136

Writing assignments in educational computing and instructional technology classes
Rebecca Brent 143

Individualized planning and facilitation in teaching educational computing strategies
Julie Q. Bao 147

Multimedia **151**

Integrating computers and curriculum content in higher education
Mary S. Anderson & Vikki Howard 153

Incorporating CD-ROM technology into the curriculum
Ray Braswell & Jennifer Brown 159

Putting together the multimedia electronic classroom
Ali Jafari 162

Mindful hypermedia: Teachers as authors
Esther Javetz 166

Marketing schools through multimedia: How San Diego Magnet Schools "sell" themselves to the public using technology
Carol A. Kerney 173

How soon will teachers use virtual reality in the classroom?
A discussion of the proposed use of virtual reality in San Diego Magnet Schools
Carol A. Kerney 178

The interactive VCR: An alternative approach to developing interactive multimedia
Donn Ritchie & Matt Stollenwerk 182

Video-based tutorial and drill for a classical dance form
Mythili Sridhar & James Levin 187

The Magic Wall: Integrating computers in multiscreen teaching
John Swartz 193

Fostering effective communication during the student teaching experience:
The video connection
Maryanne R. Bednar, Francis J. Ryan, & John J. Sweeder 196

Inexpensive, new technology (PhotoCD) centerpieces:
Southwestern College's bilingual, interactive Macintosh orientation to the College Library
Ron Vess & Bill Alexander 200

Concepts & Procedures **204**

Technology and education: Are they really compatible?
John Watkins 206

Teaching teachers to evaluate software: A system and an example
Cleborne D. Maddux 212

Using technology in the classroom: Today and tomorrow
Tony Mitchell & Marcin Paprzycki 219

A novel database lesson for preservice and inservice secondary teachers
Nada L. Mach 224

Establishing a new course: Design and presentation of information
Joyce Kupsh 230

AIMS CoPlanner: Computer technology supporting collaborative decision-making across the curriculum
Robert Sanche, Leonard Haines, & Gladene Robertson 234

Copyright: Rights and liabilities of authors and users of multimedia presentations
Diane B. Hoadley & Michael R. Hoadley 239

Helping faculty to cope with the classroom in the year 2000: How to get a head start
L.F.(Len) Proctor 244

ABC's of designing and developing a media production laboratory for education majors
Judy Lee 249

Choosing computer hardware for instruction: Asking the right questions
Shirley Gartmann 251

Technology Diffusion 256

The mind as a channel: A paradigm for the information age
Elizabeth Anne Viau 258

Technology in the schools and the challenge of collaboration
Gary R. Brown & Jerry Logan 264

Integrating technologies into the curriculum: Why has it been so slow, and how can we speed it up?
Donn Ritchie & Karin Wiburg 268

A staff development model for technological change
Christene K. Bennett 273

A realistic approach to technology in teacher education
Martha C. Yopp 279

Integration of student learning strategies via technology
Michael K. Smith & Charles Wilson 283

Technology in teacher education resulting from restructuring and university initiatives
Raymond Ramquist 286

Integrating technology into teacher education
Sue P. Reehm & MaryAnn Kolloff 289

Model for creating a computer-using teacher education faculty
Neal Topp, Ann Thompson, & Denise Schmidt 292

The Roving Workstation Project: A model for improving teacher education faculty use of technology
Julie A. Poage & Dorie E. Munson 296

Faculty collaboration: A critical component in applying new technology in teacher education
Ronald J. Abate & C. Lynne Hannah 300

New partnerships: Helping faculty integrate information technologies in the curriculum—the Learning Technologies Program
Carrie E. Regenstein 305

A staff development project: The Model Schools Program
Roosevelt Wardlaw 308

Q-Schools: Deming, technology and teacher education
Ralph Cafolla & Dan Kauffman 313

The design and assessment of an inservice technology planning program
Barbara K. McKenzie 318

Preparing teacher leaders and change agents for technology in education
Neal B. Strudler & Richard R. Powell 321

The role of the National Science Foundation in supporting innovative technologies in pre-college education
Michael Haney, Marjorie Enneking, & Nora Sabelli 327

Preservice Teacher Education 334

Selecting computer applications: A model for preservice teachers
David C. Byrum 336

The use of technology in early childhood classrooms: A constructivist approach to teacher education
Juanita V. Copley 341

Technology enhanced cases
Michael L. Connell 345

Visions of the 21st century school: Implications for restructuring the preservice instructional media/technology course
Charles W. Dubenezic 350

Process-centered applications in field based teacher training
John Meyer & Penny Lee Shnay 354

Managing information: Using the computer to increase productivity—meeting the needs
Robert K. Hess 357

Modeling instructional change using interactive multimedia in teacher training
LaMont Johnson & Steven Harlow 361

A permeated approach to technology in teacher education
Brent Robinson 363

The implementation of computer technology in preservice teaching
Janice E. J. Woodrow 368

Computer education for teachers: Advocacy is admirable but role modeling rules
Peter Wright 374

Three case studies of preservice teachers perspectives toward computer technology
Thomas A. Drazdowski 381

Teacher education: Retooling with technology
R. Michael Smith 386

Learning technology: Implications for practice
Dale C. P. Howard & Peggy Ann Howard 389

Cultural sensitivity in classroom computing
Inés Márquez Chisholm 395

Access technology for special populations: Not just "special" education
A. Sandy Parsons 399

Moving beyond the calculator: Spreadsheets in elementary and middle level mathematics
Ron Zambo 403

Teacher educators' uses of computers in teaching
Keith Wetzel 407

Centers for professional development and technology: CEDE in San Antonio
Richard A. Diem 411

Strategies for teaching a large undergraduate course on educational computing
Marta Fabris, Lily Wright, Tim Murphy, Linda Gamble, Jerry Price, & Jerry Willis 414

Instructional Design 421

Physical environment needs for implementing audio-visual technology
Jamal Al-Sharhan 423

Visual BASIC: A new tool for teachers
Ralph Cafolla & Dan Kauffman 425

The relevance of analogy quality in the classroom
Jerry P. Galloway 430

Making Connections : Integrating technology with the concept attainment instructional model
Eunice M. Merideth & Shahnaz Lotfipour 434

Teacher technology in the clinical setting:
The preservice teacher technology assistance program
Rosemary Talab, Jim Bogart, & Tom Hawk 440

Teaching instructional design using technology
Michael L. Connell 443

Teachers, technology, transitions: Lessons from ten years of history
Priscilla Norton 448

Accommodating students' learning styles with microcomputer software
Cynthia D. Schulz 453

The legend of the qualitative/quantitative dualism:
Implications for research in technology and teacher education
Kip Tellez 459

Instructional design + cognitive strategies = improved pedagogy
Kay A. Persichitte 464

Cognitive science: A new foundation for teacher education
Ralph Cafolla & Dan Kauffman 468

Research Section 1 471

A SAASI partnership: Educator/librarian collaboration to promote information literacy
Bernadette Cole Slaughter & Blaine E. Knupp 472

Eliminating "teleconfusion": Telecommunication training materials for teacher education
Ann E. Barron & Karen S. Ivers 476

Computers in K-12 schools: Conditions related to adoption and implementation
Deborah Y. Bauder & Rosemary J. Mullick 482

Students' thoughts and feelings during technology skills and concepts acquisition
Nancy P. Hunt & Roy M. Bohlin 488

Developing the computer-competent preservice teacher
Elizabeth Petrakis 491

Research Section 2 495

Effects of computer experience on computer attitudes among preservice, inservice, and postulant teachers
Yuen-kuang Cliff Liao 498

Preservice teachers' computer attitudes in non-computer classes
John E. McEneaney, Yee Ping Soon, Constance Sprague, & Wayne M. Linek 506

Education students' attitudes toward the effectiveness of instructional technology
Yolanda N. Padron 511

Investigating middle school students' attitudes toward calculator use
Shwu-Yong L. Huang 514

Classroom observations of middle school students' technology use in mathematics
Shwu-Yong L. Huang & Hersholt C. Waxman 519

Investigating computer use in elementary and middle school inner-city classrooms
Hersholt C. Waxman & Shwu-Yong L. Huang 524

Technology access and use in urban, suburban, and rural Eighth Grade mathematics classrooms
Emiel W. Owens 528

Instruction with technology: Differences between experienced and novice teachers
Janice Mitchell, Susan E. Williams, Hersholt C. Waxman, & Shwu-Yong L. Huang 531

Technology in teacher education: A Florida study
M. D. Roblyer & Ann E. Barron 536

School restructuring through an educational technology initiative: One state's experience
Trish Stoddart, Dale Niederhauser, & John Mergendoller 542

Technology development for educators: Three models of implementation
Lynne M. Schrum 550

Accessing ICLAS network log data to quantify student computer usage in relation to course performance and attitude change
James A. White, Andria P. Troutman, & M. R. Chancey 554

Structuring teachers' attitudinal changes: A follow-up study
Mary Planow, Deborah Bauder, David Carr, & Ron Sarner 560

Research on educational telecomputing: Collecting data via computer
Susan E. Anderson 564

Chaos and education
Ralph Cafolla & Dan Kauffman 570

Conducting technology and teacher education research: The STATE Monograph
Hersholt C. Waxman & George W. Bright 573

Mathematics & Science 576

A constructivist use of technology in elementary mathematics
Michael L. Connell 579

Computers in science: A school-based training program for applying technology to the elementary science curriculum
Sarah McPherson 583

Using technology in scientific applications of mathematics at the middle school
Phillip Makurat 587

Introductory calculator inservice for middle school mathematics teachers
George W. Bright & William P. Love 590

Graphing calculators: Networking strategies for inservice instruction
M. Jayne Fleener 596

District teacher teams integrating technology into the mathematics/science curriculum
Henry S. Kepner, Jr. 600

Computers in physics instruction: A collaborative development of teaching strategies
Janice E. J. Woodrow 605

Using multimedia with preservice and inservice teachers:
Interpretations of whole number operations
Mary Jane Ford, Carol Scott Whelan, & Anne Fontaine 610

What is computer literacy for a mathematics teacher?
Robert T. Hall, Jr. & James A. Petty 613

The graphing calculator in mathematics concept development and problem-solving
Mary Margaret Shoaf-Grubbs 618

Geometry in game settings
George W. Bright 624

Telecommunications 629

Introducing the Society for Technology and Teacher Education (STATE) Internet server
Glen L. Bull, Mable Kinzie, Tim Sigmon, & Jerry Willis 632

The Internet Express
Lisa Bievenue, Charles Farmer, & John Duban 637

An Internet-based graduate telecomputing course: Practicing what we preach
Judith B. Harris 641

Internet: An electronic extension of the classroom
Larry S. Anderson, John F. Perry, & Ken Schmidt 646

Telecommunication training materials for teacher education
Ann E. Barron & Karen S. Ivers 648

Grassroots telecommunications: An alternative teacher education resource
Edward J. Nemeth 654

Information technology for K-12 teachers
Edwin R. Smith 659

KIDLINE: Electronic fieldwork in teacher preparation classes
Susan W. Eskridge 661

Electronic conferencing: Extending discussion opportunities in teacher preparation classes
Susan W. Eskridge & Margaret A. Langer 667

911 for student teachers
Mary Ella Lowe 672

The integration of telecommunications into special education student teaching
Wenfan Yan, Julie A. Poage, Dorie E. Munson, & Mary Anderson 675

Patterns of use of an electronic communication network for student teachers and first year teachers
Ann Thompson & Caroline Hayes 680

Breaking down barriers through telecommunications
Michael J. Rush 684

Distributed schooling: A model for computer network-supported teacher education
Clinton E. Stapleton 688

Multimedia teaching at a distance: Emerging issues of computer-supported cooperative work in education and training
Niki Davis 693

Application of telecommunications to clinical teaching experiences
William E. Blanton & Max S. Thompson 696

Evaluation research on telecommunication applications in teacher education
Max S. Thompson & William E. Blanton 700

Invitations to shared thinking: Using telecommunications in teacher education programs
Sara Olin Zimmerman & William E. Blanton 703

The Appalachian Distance Learning Project: A national demonstration project in collaborative education reform
Michael G. Flemister, Colleen Sexton, & Bonnie Beach 707

Dale and Maggie's most excellent adventure: Designing a technology course to be delivered via interactive compressed video
Maggie Austin 711

Continuing teacher education at a distance using audiographic technology
Dennis Knapczyk, Thomas Brush, & Paul Rodes 716

Training distance educators for converging technologies
Farhad Saba 721

Evaluation of distance learning
Tara Knott 725

Simulations 728

Exploring teaching techniques via A microcomputer simulation
Harold R. Strang & Sara D. Moore 730

Microteaching in microworlds: Using LAN's and simulations in preservice teacher education across the curriculum
Rae C. Schipke 735

Computer networking and collaborative knowledge construction: The ICONS computer-assisted international negotiation project
Judith Torney-Purta 740

Communication, simulation, and chaos
Dora Perry-Wilson 745

Keynote Address

Teaching matters: The role of technology in education

Kathleen Fulton
Congress of the United States
Office of Technology Assessment

It's a pleasure to have this chance to share with you some of the key findings from the educational technology studies conducted by the Office of Technology Assessment over the last five years. In thinking about this paper, I wanted a title that would carry the central message of these studies. So here it is: Teaching matters. It's also a dandy pun, resonating with the matters of concern to members of the Society for Technology and Teacher Education: teaching, technology, and teaching about teaching with technology.

This paper is an overview of Congressional interest in educational technology, and covers our 1988 study of computers in schools, the subsequent 1989 study on distance learning, the technology implications raised in the 1991 testing study, and the ramifications for adult literacy in our most recent report. I will also discuss Congress's reaction and my own thoughts on the likely concerns and interests of the 103rd Congress in this area.

First some background. For those of you not accustomed to Washington's alphabet soup of government agencies, the Office of Technology Assessment (OTA) is a part of the legislative branch, created in 1972 to serve as an analytical support agency for Congress. The agency's charge is to help Congress anticipate and understand how technology affects the myriad issues Congress must deal with—from space exploration to ground water contamination, from combating terrorism to enhancing education. The agency benefits from the expertise and guidance of advisory panels of outside experts selected for each study; they provide oversight, point us in the right direction, and review and react to what we write. OTA has a unique structure that gives the agency considerable freedom and apolitical support through our bipartisan Congressional Advisory Board (with equal numbers of Senators and Representatives, Republicans and Democrats) and an external Advisory Council of distinguished academicians and business leaders. Jack Gibbons, OTA Director for the last 13 years until his appointment as Science Adviser to President Clinton, described OTA's role as an "early warning system" on technology's potential impacts on society. Dr. Gibbons liked to quote the old Chinese proverb "If we don't change direction, we're very likely to end up where we're headed." What about education—are we likely to end up where we're headed?.

Power On!: What Did We Learn?

In June of 1986 the House Education and Labor Committee asked OTA to conduct a study of current issues in educational technology for elementary and secondary schools. The Committee was concerned with the availability and use of existing technologies, (mainly computers at that time), questions of access and equity, effectiveness and costs, research and development for future activities, and availability of appropriate software as well as necessary teacher training. The resulting report, *Power On! New Tools for Teaching and Learning,* used the metaphor of "power" to suggest the excitement and electricity, if you will, that computers can bring to teaching and learning. It also suggests the empowerment computers can provide for both students and teachers. But if technology was to take hold, we suggested, this tool would have to be embraced by classroom teachers, one at a time, teachers who were comfortable with its use and aware of ways it could help them do their jobs better.

Computers, we noted, are not self implementing. Like any tool, they do the work to which they are applied, but the quality of the result depends upon the skill of the craftsperson who uses that tool. Clearly the kind of woodworking I do with a rotary arm saw is very different than the products my husband creates with that same tool—the difference comes from his skill, which in turn is dependent upon his comfort, experience, and understanding of the tool's capabilities. Until I reach some threshold of comfort with that tool, I'm unlikely to even turn it on. It's no different with computers.

We reported other findings that may seem commonplace now, especially to teacher educators with considerable computer experiences. But these findings help us understand where we are and where we're headed, and serve as markers in the road maps as we chart where we want to go. Let me, then, mention these briefly.

Most teachers want to use technology. For many, it lights a fire under their teaching, igniting sparks which may have grown dim over the years. Some teachers acknowledge that the computer is the newest tool of the teaching trade. To stay on top professionally, they recognize the need to master this latest teaching tool. Many see the importance of computers in preparing students for the technology they will face outside the doors of the schoolroom. Others see technology as a vehicle to channel students' enthusiasm into learning. Some, however, freely admit feeling just plain pressured by the technology movement and all the machines dumped on them by parents, school boards, and the community. Nonetheless, they figure it wouldn't look good if they didn't use them. These folks admit to being led "kicking and screaming into the technology revolution".

Despite various reasons for an interest in technology, we found that **most teachers aren't using technology, not in any comprehensive, compelling ways.** In a workshop of teachers we assembled to discuss how and why they used or didn't use computers, it was suggested that at best, 30% of all K-12 teachers are comfortable with computers and are thus the technology pioneers or leaders in their schools. (These pioneers and zealots made up the group that actually reads these papers and attends these conferences.) A smaller number, perhaps 10% of all teachers, fell into the "Who needs it?" group, those who would never use technology, never wish to, or see no need. But in the middle was a fertile field of perhaps 60% of all teachers, those who were interested but needed help and wanted models to show how to use technology to do important things with teaching. It was suggested that this group should be the target of training efforts, of support and hand holding, the ones to whom we should be supplying visions of change.

Today, perhaps those numbers have changed slightly, with a greater percentage of teachers now technology enthusiasts with some level of expertise, (as reflected in the increased participation every year at the NECC conference and other technology user groups and conferences) and a still small but not diminishing group who remain "Luddites and proud of it". The largest group continues to be made up of that middle block of those wanting more help. When the *Power On!* study was done, we reported that only half of all teachers said they used computers in instruction.

We found that **technology use** (and at that time technology was centered on computers, predominantly) **was limited to relatively narrow applications.** We found scant evidence of teachers using computers for teaching problem solving, for collaborating on projects, or creating their own materials. But remember, that was 1988, before the advent of multimedia, affordable CD-ROM, or resources like Quicktime. But even then, we saw a trend: moving from teaching *about* to teaching *with* computers, as teachers experience grew. But it wasn't happening overnight.

We saw that **teachers use technology in ways that work best in their own teaching styles and methods, but that these approaches evolve as teachers gain more experience.** Overall, the process by which teachers appropriate technology is far more complex than that by which they adopt other changes. Teachers need to be in charge in their classrooms but technology can sometimes undermine their authority: when the machine breaks down, when the software doesn't support their lessons, when the students know more about the machine than the teacher. These are not insignificant concerns for teachers.

Perhaps the most significant finding was the **impact of the use of computers in the classroom in changing teaching style.** Moving from the "chalk and talk" traditional delivery mode to the teacher as coach model was a clear trend. The message in *Power On!*was ahead of the conventional wisdom on this topic, and provided an early warning for educators and policy makers. Studies since then have provided continuing validation of the change in teaching that comes with computer use. A recent study, highlighting major trends and observations of teaching where computers are used regularly by teachers, underscored the shift from lecture and recitation to coaching with the following analogy: "The introduction of a third party, the computer, into the situation encourages the teacher to play the role of a coach in many of the same ways that a piano encourages the teacher to play the role of coach in a piano lesson" (Collins, 1990). When much of this learning goes on with the student working on his or her own, the teacher is a skilled observer whose job it is to encourage, guide, and make sure the student is on target, puts what is being learned in a meaningful context, and that the overall activity is beneficial to the student's learning. As the Center for Technology in Education found in their study of accomplished teachers (Sheingold and Hadley, 1990), those who use computers extensively in their teaching use a range of technologies in a multitude of ways. Using the computer has changed their teaching significantly as they move to more student-centered classrooms, give students more individualized opportunities, and present more complex material and expect more of their students.

But how does a teacher go from being a traditional teacher to an "accomplished computer-using teacher"? It's a little like how porcupines make love—very slowly and carefully! In *Power On!* we made clear that **it takes time, resources, and support.** This point, surprising to some at the time, continues to be confirmed by subsequent research. The CTE study found that, after about five to six years working with computers, most teachers move from using computers to directly reinforce what is being taught to using them to do more expansive activities: creating their own materials, playing around with existing software and data, using the computer as a general, flexible tool. The "accomplished computer-using teachers" are found in schools where extensive technology resources are available to them. These teachers come from situations where they are given support for their efforts, through formal and informal training and opportunities for sharing with their colleagues, and, most importantly, time for planning and "messing around" to see what works with their students.

In *Power On!* we called for **improvements and enhanced inservice education in technology use and applications**, but warned that this alone wasn't enough. Even the most effective inservice programs couldn't overcome two of the biggest difficulties in teaching—time and isolation. Inservice, often confined to a day or two a year, may have a host of competing requirements: in one afternoon trying to "cover" the "hot" topics of the moment, whether they be curriculum changes, AIDS education, or dealing with problems of abuse, violence, or drugs. Giving teachers a vision of how computers can change their teaching requires a more intensive and extensive time commitment. Absorbing new teaching principles, getting comfortable with the hardware and software, "fooling around" until you've made it your own—all under the guidance of competent trainers, followed up with continuing support—these elements can't be conveyed in an afternoon lecture or a three page handout. Budget crises, staff shortages and cuts in "excess" administrative personnel, like computer coordinators, exacerbate the difficulties involved in creating appropriate computer inservice training programs for teachers.

What was most frustrating of all—and shocking to many policy makers—was the finding that **new teachers coming fresh from schools and colleges of education weren't entering the classroom ready to teach with technology**. In 1988 half the states had no requirements for preservice training in technology. So it was not surprising that in an AACTE survey of teacher education students asking about readiness to teach, the area rated lowest was teaching with computers. Education faculty also saw this as the area where their students were least prepared for teaching, but they thought 58% of their students were adequately prepared, compared to 29% of the students rating themselves ready to teach with computers(AACTE, 1987). Imagine how we'd feel if medical students were similarly uncomfortable with and loathe to use the advanced technologies available in their field when they went into practice!

So What Happened?

There was an overwhelmingly positive response to *Power On!*. After sending it to our client—Congress—calls started coming in from State Departments of Education, school districts, and individual teachers. We never expected the report would become one of GPOs best sellers, but it did, for the simple reason that the education community was hungry for such a report. At that time, the Department of Education had not made technology a high priority, to say the least, so having the OTA report filled a gap. It put a lot of information—both formal research and anecdotal data—into context. Our findings had been validated by the large groups of teachers and school systems contributing to the study.

Most importantly, the report became a stimulus for further activity. The House Committee on Education and Labor used material from a background paper for the study ("Trends and Status of Computers in Schools: Use in Chapter 1 Programs and with Limited English Proficient Students") for the reauthorization of Chapter 1 and the Bilingual Education Act (H.R. 5, School Improvement Act of 1987.) The bills specified the acquisition of computer hardware, software, and related materials as one of five priority areas for use of Chapter 2 funds, and encouraged the use of technology in magnet schools programs and bilingual education programs. OTA's findings on the need for greater Federal investment in R&D technology was cited extensively in House Education Committee's report: "Educational Research, Development, and Dissemination: Reclaiming a Vision of the Federal Role for the 1990's and Beyond."

Teaching At a Distance

One tangible result of *Power On!* was a Congressional request for an immediate OTA follow up study on a area we'd been able to discuss briefly: telecommunications. No sooner was *Power On!* out the door than OTA was asked to look at "the distance learning thing".

Impressed by the potential of telecommunications for improving math and science teaching, Senator Kennedy had shepherded a major new technology program through Congress, the Star Schools Program. Congress asked OTA to look at the implications of telecommunications technologies in improving K-12 education, to help them shape the program and develop policy for this important activity. The resulting study, *Linking for Learning: A New Course for Education,* also used another metaphor to convey the central message. Links. Links between schools, or districts, or even across States. Links between students in disparate classes. Links between the telecommunications providers and public schools. The problem is an old one—how to provide equal access to quality education in all kinds of schools in all kinds of locations. Rural schools with just 3 kids eager to take AP Biology, or 6 hoping to study German; inner city schools unable to attract specialized teachers; small schools hundreds of miles from the nearest museum or cultural center; suburban schools isolated from the "real world"; teachers far from the universities that could provide continuing professional growth. Old problems, but a new solution. Increasingly, we found that schools, districts, and States are turning to distance learning technologies—cable, fiber optic, microwave, satellite, computer, or combined systems—to supply these "missing links", connecting teachers and information from as far as across the continent, as close as down the hall.

We found that distance learning has filled a gap for two equally important reasons. First, **technology developments have created systems that are powerful, flexible, and increasingly affordable.** At the same time, it is clear that **not every teaching need can or must be met by applying the traditional classroom model of one teacher standing in front of a class of 25 students.** The alternatives provide altogether new opportunities.

We were particularly encouraged about **the opportunities distance education systems offer teachers for professional growth,** from team teaching with a specialist in another field located far from the classroom, to informal sharing of resources and information and concerns over computer networks; from full-fledged courses for credit to ongoing training like that needed by all professionals to broaden knowledge, enhance skills, or even change specialities. For example, in one distance learning application, we saw a social studies teacher who monitored a Russian history class with his students, and worked with the distant instructor after hours over the network until he himself was qualified to teach the Russian history class the next year.

Sharing teachers among schools, once a geographic hassle at best, a physical impossibility at worst, is now feasible. At the time of the *Linking for Learning* study, for example, we reported that, in a survey of States looking at shortages of foreign language teachers, 38% of the States reported that they offered foreign language instruction via technology as one solution (Draper, 1988). Currently, more students in the U.S. study Japanese over the TI-IN distance learning network than by any other source. And they do better, one study found, than students taking the course in traditional high school classrooms.

But **our central finding didn't change: teaching matters.** The key to success in distance learning is the teacher. If the teacher on the system is good, the technology can become almost transparent and distance really becomes irrelevant. Conversely, no technology can overcome poor teaching—it will, in fact, be exacerbated in distance education applications. But when skilled teachers are involved, their enthusiasm, expertise, and creative use of the media can offer students enrichment that goes beyond the four walls of the classroom.

Note the recurrence of the term "skilled teachers". We found, again not surprisingly, that **teachers must be trained to use the medium effectively**. What is surprising is that some schools try to place a teacher in front of a camera and say "Teach!" It's not the same—they must find new ways to structure interaction with students, and old styles of teaching may not be appropriate. The limits of the distance learning technologies can be catalysts for instructional design and teaching techniques that enhance the learning process. The distance teacher may use live interviews with local experts, tapes and special materials assembled from broad sources, computer graphics, or other specialized resources unavailable in the receiving school. Even something as "hands-on" as a laboratory procedure can be modeled on the medium live, while students follow along in their classrooms, assisted by classroom teaching aides or facilitators who work with the distance instructor in planning lessons, monitoring the activities, distributing and collecting homework and tests, and maintaining discipline.

Other findings paralleled those about computer use: **distance teaching takes more time to prepare, more effort to compensate for the physical separation from students, and requires more organization.** "Dead time" that might be acceptable in a traditional classroom situation is unacceptable when the camera is rolling. And being on camera at all times is even more intimidating than standing in the front of the classroom. It's not for everyone. But those who are becoming experienced in the area, we found, are excited by the opportunities to be innovators, to teach the subjects they love to a wider range of students than they'd find in their home schools, to work with colleagues and teaching aids in the distance classrooms, and to use technology as a springboard for creativity.

Teaching matters. This is real teaching, done by teachers, and kids are learning. In most instances, we found, **distance learning is as effective as on site, face to face instruction in the classroom**. (see Moore, 1988).

What Happened?

The OTA study caught the telecommunications train just as it was firing up to pull out of the station. What was tentative and unique just three years ago is almost commonplace in many districts today. Is the train heading in the right direction? The timing was excellent for advising Congress on evolving issues. OTA testified several times before the House Education Committee, and the Commerce Committee, advising on revisions to the Star Schools program to expand the focus to go beyond rural targets to all areas of the country, including suburban and inner city schools (many of which can be isolated in their own ways); to go beyond math, science and foreign language focus to range of instructional applications, including using telecommunications for literacy, for reaching under served populations, and teacher training.

Similarly, State and district's have used both *Linking for Learning* along with *Power On!* as guides in developing long term school reform agendas. Many states, including Texas, California, Florida, West Virginia and Kentucky, have cited these reports in preparing statewide educational technology plans.

The Department of Education is gradually focusing more resources on technology, partly from Congressional pressure and partly through changes in attitude among administration appointees. A recent Department of Education report listed educational technology efforts in 59 funded activities conducted by 6 operating components. Fourteen of these are considered "primary focus activities, with an explicit focus on educational technology in authorizing legislation. (U.S. Department of Education, 1992).

The use of distance technologies for enhancing teacher training has been particularly exciting in the last several years. Today **distance learning technologies are providing to be very valuable resources for the inservice training needs of teachers**. For example, the Educational Telecommunications Network (ETN) of the Los Angeles County Office of Education offers an extensive range of materials for teachers, live and interactive (via telephone call-in to content specialists). This central resource has been used in all 95 school districts spread across the 4000 square miles that make up LA county, as well other parts of California and neighboring states able to receive the unscrambled video signal on the Ku-band satellite. Teacher training is ongoing in areas such as curricular reform, new assessment requirements, topic such as "ESL toolbox" and science and technology teaching. Special topics for administrators (e.g. issues of change, supervision and accountability) keep reform efforts moving and school leaders energized.

Congress continues to turn to OTA for guidance regarding topics including educational rates for telecommunications services, setting aside time for educational applications on satellites, and encouraging dissemination of effective practices. Increasingly, when future applications of telecommunications are debated, the educational community has a seat at the table . While it is still possible that schools could be left behind for lack of resources, the partnerships encouraged in *Linking for Learning*—involving school districts, universities, local industry, and cable, public broadcasting, and telephone companies as well as computer companies—have become the model supported by Star Schools and other legislation.

What About Adults?

The lessons learned from our studies of computer use in elementary and secondary schools proved a strong basis for the current OTA study on technologies for adult literacy. In this study, it has become clear that technology could be a powerful resource for literacy, but that adult literacy programs are often far behind their elementary and secondary school counterparts in technology use. Technology can provide a private, individualized tutoring resource for learners; it can give them a chance to succeed in a new educational environment, one in which they perceive a sense of security and support, and which gives them continuous feedback on progress as well as immediate reinforcement and feedback on their progress. Important as these factors are for all students, they are particularly important for those adults who experienced humiliation and failure under earlier, traditional teaching approaches. Computers put control in the hands of the learner and allow greater flexibility in scheduling, at times when a tutor or teacher may not be available, but the student is ready to learn. New portable learning devices, from notebook computers to hand-held multipurpose electronic learning aides (combining the capabilities of a thesaurus,dictionary, grammar and spelling aid and language translator), could make it possible for adults to study whenever and wherever they find the time—at home after the kids are in bed, on the bus, on breaks at work. And television can bring learning into the home. The GED on TV series offered by Kentucky Educational

Television alone has made it possible for thousands of adults to obtain their high school degree; other series are expanding the use of television, especially as new interactivity is available through computer and telephone linkups.

The adult literacy study raised issues regarding teachers and technology paralleling what we found in earlier studies. But these concerns are even more problematic in adult literacy, where the majority of teachers work parttime, were trained in different specialties (K-12 rather than teaching adults), and have even fewer resources available for professionalization and training. Technology use is lower in adult literacy programs; although among the patchwork of service providers make it difficult to collect the data, OTA estimates that only 10-15 percent of all programs use computers for instruction. Most adult literacy programs rarely have the sustained funding necessary for planning for technology purchases or the experienced staff or volunteers knowledgeable about technology.

What's Next?

The world of educational technology has changed a lot since our first study, especially in the areas of software development and broader access to a range of increasingly powerful, flexible, and friendly technologies for most students. That's all the good news. But we suspect today the greatest difficulty remaining is the problem of the needs of teachers. Teaching matters, yet the area most resistant to change has been providing teachers the time, training, and visions they need, helping them find opportunities to do things differently with technology. Some have suggested it's too late—technology has advanced to the point that we do not need teachers. Technology, they claim, has already replaced teachers, and much more efficiently (Perleman, 1990, 1992).

I don't buy that. All the lessons of the last four studies tell us otherwise—Teaching Matters. But what could Congress do to create a marriage of teachers and technology? We think that's the next question on the agenda. One area of special concern is your baliwick—the training new teachers get in education schools. We've done some background work on the topic, thanks to a comprehensive literature review by Jerry Willis of the University of Houston: this paper has given us a sense of how little has changed in teacher preparation for using technology innovatively. We hope to be able to share some of those results soon. I have prepared this paper for delivery at the STATE conference and for publication in the *Technology and Teacher Education Annual* because Congress continues to turn to OTA for a picture of where we're headed—is it where we want to go? In preparing for the questions of the 103rd Congress, I want to hear what you are doing, to see what's changed, and what's blocked changes you'd like to make happen. Where could Federal policy make the biggest difference: help support education schools to buy hardware and software, or train professors? Set up networks across education schools or advanced training facilities using the best from around the country, similar to the National Technological University for engineers? Supporting more innovative student teacher models, internships with Master Technology Users? Providing forgivable loans to bring a new breed of teachers into the schools—or to help retrain military personnel interested in teaching?

That's why I'm here. Tell me your tales, show me your best stuff, cry on my shoulder. Let's go forward.

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DIVERSITY

Preparing teachers to deal with diversity is a priority in teacher education today. Assuring that we do not support inequities as a consequence of that diversity is a moral imperative. As some of the authors in this section caution, technology can be one more way to reinforce existing inequities or to create new ones. Or, as others suggest, technology can be used to overcome past inequities and create better educational environments for all students. The choices we all make must be thoughtful choices as we attempt to incorporate technology more effectively in our programs. That effectiveness must be evaluated in light of the consequences that our choices have for the students our own students will teach.

To begin this section, Brent Robinson looks at England's approach to Instructional Technology. He draws specific attention to the political implications in our uses of technology. He also points out the importance of making our students aware of how their professional lives, and their uses of technology, may be influenced by not only the political domain but the social, economic, and moral domains as well. He stresses the responsibility we all have to prepare our students to be able to critically evaluate their use of technology in light of this complexity.

Rosemary Skeele looks at multiple causes of disparities in computer usage including socio-economic status, race, gender, ability level, and exceptionality. As she indicates, these forms of diversity contribute to disparities in the use of other forms of technology as well. There are many root cause of these inequities. Other authors in this section address some of them.

Armitage's focus on the gender gap in computer usage reinforces the subtly with which many inequities occur. As she indicates, most of us do not see ourselves as part of the problem but most of us, also, do not seem to be doing much to change the situation. We bring assumptions with us regarding technology that serve to place some students at a disadvantage. She identifies some of the causes of the gender gap in computer usage and prompts the reader to consider how their own taken for granted assumptions may be a contributing factor.

Although computers and other technologies can be used to foster educational opportunities for language minority students, Hunt and Pritchard note that "few teachers serving language minority students employ computers in their teaching." In their own work they found that none of the instructional modifications made by teachers working with these students were technologically based. They note an additional barrier to using technology to help mitigate inequities—teachers lack of resources and training.

Bohlin, Bohlin, and Benavides look at how one particular language minority group—the Hispanic population of students—is at a particular disadvantage in

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terms of computer usage. Their attitudes about computers influence their perception of their usefulness. In addition, the authors suggest that there may be cultural barriers to changing those attitudes. The taken for granted assumptions that are a reflection of our cultural embeddedness may confound all of our aims, not just those of our students.

Multimedia personal computers hold exciting potential for second language acquisition according to Dennis Nulman. He moves the discussion forward by suggesting that the strength of MPC's may lie, in part, in the authenticity of the learning experiences they are able to provide for students. In addition, the valuable feedback on student learning that will be provided with the use of MPC's cannot be underestimated. All of the factors influencing student learning must be considered as we assess the authenticity of the learning experiences provided for students — authentic learning must be a concern of all educators. This places significant responsibilities on those of us who use new technologies to educate teachers.

Multimedia is also the focus of Picciano's paper. He discusses a multimedia program designed to help students become sensitive to issues of diversity, particularly as it contributes to group conflict. Through the use of multimedia students are immersed in the complexity of a "real" event and their learning becomes more meaningful. Working through "The Five Points: A Multimedia Experience in Social History" students learn the limitations in a single perspectives and the value in multiple perspectives. One way to help our students learn to deal with diversity in their classrooms, as several of this sections' authors suggest, is to provide them with opportunities to see the validity in perspectives different from their own.

Ford, Zink, and Jackson provide a practical step by step example of how teacher educators can use multimedia to develop richer, more comprehensive instructional units. They discuss how various forms of media can be used to supplement one another. Just as a single perspective limits one's understanding, limited use of media makes a teacher's lessons less than they could be.

The section on diversity ends with a piece by Clark, Hosticka, and De Neuilly Rice. Looking at the NEW South Africa they provide a clear picture of how a student's difference can be used to "justify" inequity. They, in turn, build a case for how technology can be a powerful tool in redressing some of those wrongs. They provide a wider lens for our observations and provide a strong argument for how technology can be used to overcome the disparities resulting from years of inequality based on apartheid.

Our cultural embeddedness reflected in own taken for granted assumptions, our attitudes, and our perspectives as well as policy and a lack of resources and preparation influence the use of technology in educational programs. Too often, as many of these authors suggest, this leads to significant inequities. They also make clear that to make learning meaningful—authentic—teachers must not ignore the diversity in classrooms but rather they must consider their students' differences if they hope to plan learning experiences that are meaningful for all of them. It is the responsibility of all of us in teacher education to provide our own students with opportunities to begin to learn how to do this. The authors of this section provide many good suggestions for how to begin and as one of them reminds us, "educational progress can come directly from one concerned individual. That person could be you."

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The politics of technology in education and the role of teacher educators

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Revolution may seem a strong word to describe the advent of "educational computing". It isn't. Nothing before has so stirred schools into action. School systems, teachers, parents and children talk about computers as they never talked about programmed learning, educational television, open education nor raising the school learning age, for that matter. Schools must have computers! People talk about how children are captivated by computer assisted learning (CAL) while others stress computer-based jobs. . . . Others point to the demands of a technological culture when urging schools to use computers. . . . The range of possibilities is exceptional. No other technology has been thought to have such potential (Olson, 1988, p. 1).

Initial teacher education is intimately caught up in this revolution. Training institutions often experience directly the same pressures felt by schools. In the UK, for example, schools have been mandated by the Government to use technology and every teacher training course must now contain "clearly identifiable elements which enable students to make use of information technology (IT) in the classroom" (CATE, 1992, p.10). Even where training institutions are not directly subject to pressure, in order to fulfill their teacher training responsibilities, it is essential that training programmes in colleges and universities reflect the ways that schools can and should use technology. In the USA almost every teacher training institution offers at least one educational technology course (Ely, 1988). Teacher education courses, however, tend to focus on the mechanics of technology or on how to use technology to teach. UK courses are typical in this respect whereby intending teachers are required to learn to:

1. make confident use of a range of software packages and information technology devices appropriate to their subject specialism and age range;
2. review critically the relevance of software packages and information technology devices appropriate to their subject specialism and age range and judge the potential value of these in the classroom;
3. make constructive use of information technology in their teaching and in particular prepare and put into effect schemes of work incorporating appropriate uses of information technology;
4. evaluate the ways in which the use of information technology changes the nature of teaching and learning (CATE, 1989, para 6.6).

Teacher education courses (as opposed to training courses) should help teachers move beyond such functional competence. The computer is a powerful tool and a potent symbol in our society. Politically, it is particularly highly charged and instrumental. There will be many pressures upon intending teachers to use computers in schools and considerable demands may be made upon them, some of them perhaps unrealistic or not obviously desirable. Those teachers need to realise that the issues are not just pedagogic. They need to understand both the symbolic and the instrumental aspects of the technology and the interplay between them. To make a truly professional response to technology, intending teachers need not only to be prepared with the skills to use it but also to be equipped with a wide cultural perspective which allows them to see clearly and critically the value- laden nature of the technology, motives propounded for using it, and the consequences for ways in which they and their pupils should use and think about the technology. In particular, education, as a crucial social institution, is being subjected to the demands of the new technology and the social values inherent in it. Consequently, intending teachers cannot understand the challenge of the computer, or the context in which that challenge is being cast, without reference to the "outside forces," notably industry and Government (Self, 1987), that are mediating our experience of IT. This paper is primarily concerned with beginning to outline some of the important political issues in the belief that an understanding of these is required before we, as teachers or as teacher educators, can begin to address the use of technology in education.

Technology, Education, and Vocational Need

A commonly articulated motive for placing technology in education is vocational need. England has been typical in this respect with a belief in the vocational function of education being employed to jusufy the introduction of computers in schools. In the 1970s there had been growing disquiet about the function of English education and its failure to respond to the demands of the economy, especially with regard to technical and science provision. By 1980, despite a change of political party in power, the view persisted and the Government embarked upon a substantial microtechnology programme for schools. It was first called for by a backbench politician (who came then to be promoted to Minister for Information Technology and, later, Secretary of State for Education) in the Guardian Newspaper on December 31st, 1980:

> Within a year or 18 months every secondary school should have a microcomputer. . . . Several teachers from each school should undergo a Computer Assisted Learning course in the techniques and usage of computers. . . . The aim should be that within three years every boy and girl who leaves school should be familiar with computers and associated technology, and have acquired a simple digital facility and some experience in using and understanding them.

Ten years further on documents produced by the government appointed National Curriculum Council (NCC, 1992) continue to state that children should be prepared for their future roles as producers, consumers, and citizens in a competitive, technological society and that schools should give support for the present use of technology in industries.

In a recent study Preston (1992) found that schools had responded to this vocational imperative. Indeed, she found that schools used technology overwhelmingly in a vocational way; that is, as a preparation for work. Intending teachers need to be prepared for this situation — it is one not always recognised by their trainers. It certainly is not one which teacher educators necessarily find acceptable. Intending teachers need to scrutinise carefully the extent to which schools can or should fulfill a vocational function in modern technology. It is interesting that at the same time that the British Government was articulating its vocationally-oriented microtechnology programme for schools, two opposition politicians were expressing a different view:

> Of course it is true that industry needs skill. Indeed as technology advances it will be skilled rather than unskilled labour that will be required, and the kind of skills demanded will change rapidly. . . . But to thrust this into the central place in the educational debate is to misread the changing role of employment in society, and to miss the great opportunities which that change makes possible for human welfare and development. If education for children and young people is about preparing them for life, then it must be preparation for full life, and not merely for employment (Clemitson and Rodgers, quoted in Fothergill, 1988, p. 19).

In the vocational debate, while arguing about the type of technological education required and the degree of technological skill which it is possible and proper to provide in schools, it is cautionary to note that it can easily be assumed that the primary purpose of education is to train pupils to fit uncritically into the workforce. (Levitas, 1986; Simon, 1988). The English Government specifically constrained what it considered to constitute a legitimate technological education:

> It will not cover specialist training in microelectronics since neither the schools nor the majority of further education courses need to be concerned with how microprocessors are made or the details of how they work. . . . nor will it be concerned with promoting studies of the wider long-term implications of microelectronics for society — for example on employment and leisure patterns or on re-training and the general provision of adult education (DES, 1979).

It is very easy to become victim of an uncritical acceptance of technology. Computers are presented as beneficial, economically competitive, efficient, growing in importance, and essential for national economic advancement. They have positive sets of associations or significations to do with such abstractions as rationality, efficiency, status, and progress. In fact, computers are not neutral. Boyd-Barrett (1990) points out that missing from such a cluster of values are the less positive or competing views for what some may see as cultural imperialism: that a market economy is not the only economy; that there are other areas of life and experience felt by some to be more important to a healthy individual or nation; that there are aspects of life to which the application of computers, though possible, may not be socially desirable; that computers may be far too expensive for some social groups or nations and thus that the advance of technology simply widens the gap between these groups and disadvantages yet further those with less technology.

Technology and the Enhancement of Learning

As soon as computers were introduced into schools, for whatever reason, observers noticed the effect they could have on the quality of learning. This potential proves alluring to teachers, more so than any vocational mandate, and is offered, especially by politicians, as a further inducement to technological innovation in schools. In England during the 1980s, as a result of what teachers began to discover about how computers could enhance their teaching, the British Government refined its vision. It wished to see computers used not only to prepare students with vocational skills but also to enrich the whole curriculum:

The Government recognises the tremendous potential of IT as a classroom tool. Our policy is to promote IT in schools and see that it is used to raise educational standards. Our goal is ambitious: it is nothing less than the full integration of IT into all classroom studies. We want to increase the extent and effectiveness of schools' use of IT for the enhancement of teaching and learning for pupils of all ages and abilities right across the curriculum (John Butcher, Speech as Schools Minister, 12th July 1989).

The extent to which such ambitious goals can be realised in schools must however be given critical consideration. While the English Government has allocated substantial financial sums for the provision of hardware, software, training and support in its schools, the financial commitment is still insufficient to meet fully the Government's aspirations. Indeed, it has become obvious that there is now a marked decline in government investment in educational technology. This can perhaps be explained by the fact that the Government no longer sees technology as the political instrument it was thought to be. The above speech indicates quite clearly that technology was to be used as the catalyst for educational change in order to increase standards. However, by the late 1980s, the Government had become impatient with the speed of technological innovation in schools, and thus also with the slow increase in standards that was supposed to follow:

The central aim of the strategy is to harness the potential of information technology (IT) for enhancing the quality of teaching and learning across the curriculum. . . . But there is still a long way to go if IT's potential is to be fully exploited. It is still not a part of the teaching repertoire which all teachers fully appreciate or feel comfortable with; and for many pupils, access to IT is by no means the commonplace activity which it needs to be if the greatest benefit is to be gained (DES, 1987, para. 2).

In 1988 the Government legislated for change. The Education Reform Act introduced a National Curriculum prescribing what was to be taught in schools together with other measures to force schools to adopt what the Government wanted. In this context, while computers are still acknowledged to enhance teaching and are seen to be necessary for the vocational training of the next generation, they are not so vital to the Government's educational programme — they are not the powerful vehicle for change they were thought to be. Direct legislation has taken over. While computers remain a part of the new curriculum they are eclipsed in significance by other features of the immediate, wide, and far reaching educational changes ordered by the government.

Goodson (1990) says that government support for technology in schools should not necessarily be seen as anything more than a process of symbolic action. In presenting the currency of symbolic action, Goodson quotes, by way of example, the British Labour Party leader talking about his party's campaign for election: "The campaign deliberately selects symbolic policies - such as under-fives provision, cervical cancer screening, a ban on lead in petrol, and home improvement grants - to illustrate our commitment to general values." Goodson claims that the introduction of computers in schools can be understood as an example of symbolic action illustrating and invigorating commitment to particular values. All societies view their educational systems as means of transmitting cultural values and national identity. Computers can be seen as symbols endowed with powerful connotations. The very appearance of a computer in a school becomes a vehicle in this process to be discarded when its symbolic currency is exhausted.

For teachers in Britain, the window of technological opportunity may now be closing as the Government appears to lessen its enthusiasm and practical support for technology in schools. If Government no longer enthusiastically supports technological innovation, teachers might lose more than a significant direct source of funding. A Government shift in attitude could adversely affect the support coming from elsewhere within the educational system and beyond. It could even affect the enthusiasm of parents and children. Without the pressure brought to bear by these bodies and the practical assistance often offered, technological innovation will become more difficult even for those teachers who do believe in the potential of computers to make them more effective teachers.

The Politics of Technological Design

This paper has been concerned primarily with the educational setting of computers rather than with the hardware and software itself. But technological designs are also social designs. Cultural values, economic interests, and political decisions are as integral to their composition as mathematical calculation and motors (Jansen, 1989). Boyd-Barratt (1990) points out that the design of both software and hardware reflects particular values and choices which in turn embody a wide range of considerations, including economic, political, social, and ideological ones. Computer hardware is a product largely controlled by a few multi-national companies. Increasingly too, the same can be said of software. Certainly in the UK, after a brief period in which there was a remarkable flood of educational software, it became obvious by the end of the 1980s that the indigenous British educational market was too small to sustain such production. Many software publishers disappeared and there has been a marked shift of focus onto the acquisition of the more flexible commercial, often international, products — word processors, spreadsheets, and databases — which are still available because of the larger market which is open to them. The type and range of hardware and software which exists for school use therefore reflect the values of the market context in which the products were manufactured and the needs of the commercial purchasers in those markets. Teachers need to be aware that their use of technology can be construed as a political act not just in terms of their aims in using it but also in terms of what the technology represents. It is very easy when working with electronic technology to forget that the way a computer manipulates and presents information is a construct, in part socially determined and only one among many. Technology urges its users to accept and work within one particular cultural frame and presents that frame as the dominant one.

An Agenda for the Future

To date, there has tended to be a silence in education around the issues raised in this paper. For example, a computer search of library articles and publications in the UK by bodies like the National Council for Educational Technology revealed almost nothing was being published on the politics of technology in education (Matthews, 1992). This however has not necessarily been mirrored in what is happening to the school curriculum. In the new English National Curriculum there is an important emphasis on pupils' awareness of the applications and effects of technology. It may be that the advent of a National Curriculum in England forces teachers (and in their turn, teacher educators) to attend to some of the political issues. For example, it is now prescribed that pupils of early Primary school years should be encouraged to reflect upon their use of technology at home and in school, to describe their use of technology and compare it with other methods. By the time pupils move on to secondary school, they should be considering further application in the outside world; the eventual aim is that students should be able to stand back from technology and evaluate its impact on themselves, other individuals, organisations and society, discussing the ethical, moral, and social issues raised by the technology.

If pupils are to achieve this understanding, then it is vital that there exists a body of teachers equipped to enable them to do so. Of course, these particular elements of the educational technology curriculum have a coherence given to them by concepts in the social, political, economic, and moral domains. They should thus form particularly important aspects of the teacher education programme for those intending to teach those specific subjects. It is however important for the political dimension of technology to permeate teaching throughout the whole curriculum for there are considerable cultural issues to be considered whenever this value-laden technology is used. So often when we employ software or hardware in the classroom there are political issues related to content, form, function, and perception potentially available for examination. Teacher educators have a responsibility to ensure that as student teachers go into schools they are all aware of the issues so that they can explicate and mediate them to advance their own pupils' understanding of technology.

But even when teachers do not choose to attend to such teaching matters directly, teacher educators have a duty to help all teachers towards an understanding of the issues they ought to face in schools. Intending teachers need to be prepared for the teaching context they will be entering: to understand the genesis and purpose of the technological demands and expectations placed upon them (individually and collectively) and the resources and support available to them as a result; they need to examine the aims and goals of their teaching within this context and thence to consider the potential of the computer, realised or not, as both an evocative symbol and as a powerful instrument.

For teacher trainers there is a third imperative. They have a duty and are in a position to explore critically why we should use computers in schools. Technology has numerous social and political implications and there are important debates occurring around technology and education. These debates may have profound implications for both schooling and for the society it serves. Teacher educators must enter this debate. Political imperatives must not be accepted uncritically. They need to be examined for what they are and their value within the education system evaluated. Teacher educators and serving teachers have always been very clear about trying to represent the different aspects of political debates. They have tried, with a great deal of success, to maintain a balanced position. However, with technology there has been what Matthews calls "a socially structured silence" in education around some issues with which teacher trainers, and teachers, are largely colluding (Matthews, 1992, p. 210). Teacher educators must enter the political debate directly in order to provide a balanced and informed perspective and to determine its course. Within their own teaching, they must finding ways of addressing the issues centrally and in sufficient complexity for teachers to think critically and to come to informed decisions about the place of technology in school and in society and thus to determine what they in their own classrooms should teach about technology and how they should use it to affect and effect their own and their pupils' futures.

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Technology and diversity: Resolving computer equity issues through multicultural education

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"With the introduction of computers into the classroom, groups suffering past educational inequities now suffer one more, the technological inequity" (Fredman, 1990, p.i).

Today in education the utilization and integration of computer technology is considered extremely important. The National Science Foundation estimates that more than three million computers can be found in schools. Researchers have reported the efficacy of computers in education for the past three decades. They are used for a variety of learning activities and their value within the discipline has been established.

Rationale For Technological Equity

In 1983, the U.S. Department of Education reported that computing was the fourth basic skill. Many feel that knowledge of computing and its application to one's occupational field will be a major determinant of a person's role and position in society in the near future. Educational access to computers and computer training will contribute to the success or failure of students' careers. In the next century there will also be demographic changes for which educators must be prepared. The world's population in 2025 will be less than nine percent Western and Caucasian (Hodgkinson as cited in Gomillion, 1991). The United States is already beginning to reflect this change. Many educators have not yet recognized that most of the world is not western, or Christian, or male, or white, or middle class, or that "In fact, women of all races, non-white males, and immigrants will constitute 85% of all new entrants to the labor force by the year 2000" (Hudson Inst., 1987, p.xiii).

Multicultural education is an endeavor by educators to deal with various types of diversity found among students in their classrooms (Sleeter, 1992). Its intent is to create an inclusive curriculum that gives students an accurate representation of the real world. It addresses all of the differences that create computer inequities. As computing became established as a tool and a subject area in schools, researchers observed that certain groups of students suffered from technological inequities. Studies indicated that students may be denied access to computers and computer knowledge because of socioeconomic status (SES), race, sex, ability level, and exceptionalities (Campbell, 1988). Equitable computer education is as important as access. Recent studies reveal that even with access to hardware, the above groups suffer increased social disparities if their knowledge base is not equitable. Equal access to computers, by itself, will not eliminate educational discrepancies or decrease individual differences between students (Levy, Navon and Shapira, 1991; Sutton, 1989, Webb, 1986).

Discrimination may be subtle, unnoticed, and inadvertent; however, the effects are as detrimental as if they were planned. The classroom teacher is in an excellent position to observe technological inequities, as well as being the one most able to initiate corrective actions (Fredman, 1990). Teachers must recognize and respond to the computing needs of multicultural populations. Since computers are used throughout the content areas, teacher preparation programs must address these needs with multicultural concepts and activities.

Disparities in Educational Computing

Less frequent educational computer use by groups other than males or high ability level students has been noted in the research for some time. During the microcomputer revolution of the early 1980's it became very apparent that microcomputers were an integral aspect of the educational process and anyone denied their use was going to suffer (Campbell, 1988). It is indisputable that the classroom computer is not shared equally. To avoid perpetuating disparity teachers and teacher educators must confront their own actions, attitudes, and situational responses and model and initiate change (Nye, 1991). It is important for future teachers, as well, to learn to make adjustments in curriculum, learning techniques, and software in order to end the prevailing discrimination. Some of the ways in which the disparity in educational computing occurs will now be discussed.

Socioeconomic Status

The importance of wealth as a determinant of computer equity cannot be ignored. Lack of fiscal resources is most often reported as the reason for not purchasing a home computer. Rodgers (1990) noted that owning a home computer influenced parental attitudes about computer use. Parents who owned and used computers had more positive feelings about educational computing, and more frequently helped their children gain proficiency in computing. Fraser (1991) observed that elementary and middle school students evidenced academic improvement when a computer was made available to them at home. High school students, lent home computers, enrolled in science and math courses they normally would not have selected, achieved success, self-esteem was increased, and educational and job opportunities were expanded (Merriman, 1987).

Levy et al. (1991) note that parental involvement may be the most influential factor in determining a child's computer education. Their study revealed that affluent parents had more involvement in their children's schooling and recommended computing curriculum that would allow students to attain higher level thinking skills. Low SES parents were not able to discern differences in educational computing activities and were content with whatever computer skills the school offered. In low SES schools drill and practice programs formed the highest percentage of computing assignments. Wealthy students directed the computer and poor students were directed by the computer (W. H. Dutton, Rogers, and Jun, 1987). For the poor, education is often expected to be the equalizing force. Unfortunately, they are shortchanged on many levels both at home and in school.

Race

There is a strong correlation between wealth and race in the United States. Minority groups—Blacks, Hispanics, and Native Americans—constitute the majority of the poor (Sutton, 1989). Disadvantaged schools, bussing, no home computers, less rigorous curriculum, no role models, and less parental pressure are socioeconomic factors linked to race (Fredman, 1990). Drouyn-Marrero (1989) reported that in a regular classroom setting white students were given more opportunities to use computers and that the setting did not contribute to the success of Hispanic or other minority students. Lockheed (1985) agrees that black students have less computer access than white students. Webb (1986) observed that schools in New York which serve black and minority students provide less access to computers than schools serving white students.

Many research studies have concluded that computer technology is an essential educational tool for minority students, many of whom are at-risk students. Goodspeed (1988) reported that the number of at-risk students was reduced through positive learning experiences provided with computers. Increased self-esteem is often noted as a result of successful computing experiences and elimination of discipline problems has been described (Boback, Tengler, Diamantes, & McMillan, 1990).

Telecommunications opens channels for minority students to communicate with peers from other SES groups, usually for the first time. Removing barriers through telecommunications may be an important step toward equity (Fazzini, 1990).

Gender

Studies indicate that men and women acquire knowledge by different means (Nye, 1991) and utilize computers in dissimilar ways (Valauskas, 1992). Most computer software packages support male learning styles. Competitiveness, assertiveness, noisy sound effects, stereotyped vocabulary, and biased graphics are typical. "Men use computers to recreate their universe, to put power, control and genius at their fingertips" (Valauskas, p. 88) while females relate to computers interactively in a social context. Women want to exploit the connectivity of the technology to enhance human communications.

School computing situations tend to alienate girls because they do not provide the social contexts in which women are comfortable. Girls generally do not join all male groups or groups of strangers, do not aggressively pursue equitable computer time, like to work in teams, and enjoy using computers for applications other than programming. Research has shown that women will avoid optional computing activities because they do not complement female learning styles (Fredman, 1990). Women have the least access to computers at the middle school level and at the high school level word processing is the only utilization area where females predominate. In a major study most schools acknowledged that males control academic computer use (Becker & Sterling, 1987). A case for eliminating gender bias is easy to make since learning techniques that support girls are also beneficial to other school groups (Sutton, 1989).

Gender bias is apparent in ads for computing equipment and supplies. Fredman (1990) reported that computer ads principally used pictures of men. Research by Ware and Stuck (1986) examined women's roles in advertisements and noted that the ratio of women to men was 2:3 and that females were depicted in sexist situations, subordinate roles, and low status jobs. Parents are obviously influenced by stereotypes. More computers and software are purchased for boys than for girls, three times as many boys as girls attend computer camps, and parents' computing expectations for girls are lower (Kramer, 1990; Nelson & Watson, 1991). Without role models or support from home or school, women are often reluctant to pursue the field because they feel incompetent.

Ability Level

Recent studies have investigated the relation between ability level and computer access (Becker & Sterling, 1987; Kirby, Oescher, Wilson, & Smith-Gratto, 1990). Frequently, electives and advanced courses in computing are reserved for students with high scores in math, have prerequisites in programming, or bear other conditions not actually required. These requirements discriminate against women and those who have exhibited average or below average achievement levels (Sutton, 1989). Kirby et al. (1990) indicate that average students in a regular classroom have less access to computers than specific subgroups, "...the chances of the regular classroom student having access to a computer in school were less than half those of special education and gifted students" (p. 539). This study and others indicate that students rated as gifted had the greatest amount of in-school computer access.

In a national study Becker and Sterling (1987) similarly report that high achieving students have greater access to computers as well as a lower pupil-per-computer ratio. High ability classes averaged two students per machine while the mean ratio in regular classes was 7:1. They noted a considerable difference in the type of instruction offered students of differing ability levels with low ability students using more drill and practice while high ability students performed tasks that required thinking skills. Since numerous studies report success teaching computing to students having various ability levels, strategies to eliminate discrimination by ability level are needed.

Exceptionalities

For students with various exceptionalities, both mental and physical, the computer has been called an enabling tool, transcending barriers and equalizing the learning situation. The computer is a very efficient communication link for both the physically and developmentally impaired, allowing them to attend regular classes and to demonstrate their capabilities to others (Budoff, 1982). Computer games are a recreational activity that allow disabled students to interact with unimpaired classmates.

Individualized learning and pacing, features of computer software, are particularly helpful for students with limitations. For them, computer instruction compares favorably with traditional learning modes. Many studies have reported that for equivalent tasks computer assisted instruction (CAI) produced superior results (Wade, 1989). In addition, attitude changes are often noted. Esteem and confidence are increased when using CAI since the computer exhibits few of the human imperfections that inhibit learning for the disabled such as prejudice, frustration, impatience, or discrimination.

Often access to computers is inadvertently denied those with disabilities when budgets or unthinking administrators do not allow the purchase of modifications or special attachments necessary to accommodate those with physical handicaps (Rotondo, 1992). The physical layout of a computer lab may also prohibit access by handicapped students. D. H. Dutton and L. Carlisle (1988) speculate that the greatest problem is not a shortage of computer resources for those with exceptional needs but ignorance of the current technology. An administrator of a computing program for the disabled at UCLA agrees that lack of awareness, coupled with perceptions about cost, cause schools to continue using conventional support services for disabled students. Most traditional support efforts do not encourage independence or promote self esteem. Today many enabling computer devices, whose costs are not prohibitive, are available (Wilson, 1992). Parents and professionals must work together to identify and implement computing technology to enable the handicapped.

Designing Change

Providing equal opportunities for every student to become involved with technology is a goal for all schools. Learning activities should be multidisciplinary and include a variety of learning techniques. If there is evidence of inequity in a school, action is indicated. Some suggestions and activities for effecting change are:

- model behavior that encourages equity and values all students;
- integrate computer use equally into all areas of the curriculum—not just math and science;
- analyze location of computers in the school;
- devise a fair use schedule that allows equitable; computer time for all students;
- eliminate superfluous prerequisites for computer courses;
- make computing a requirement for all students;
- apply varied and innovative strategies (e.g.. cooperative learning, peer tutors) to teaching computing;
- prepare all teachers to address equity issues;
- develop software evaluation guidelines that incorporate computer equity;
- purchase gender neutral, bias free software;
- avoid highly competitive or violent software
- use the technology to teach both high-order (thinking) and low-order (drill and practice) skills to all students;
- develop positive student attitudes about computing;
- illustrate practical uses for computers;
- plan to include diverse groups in computing activities;
- devote more time to less enthusiastic and less able computer users;
- introduce students to diverse role models to reduce stereotyping;
- promote student interaction while computing;
- incorporate the computer into extra-curricular activities (e.g.. sports stats, school newspaper);
- develop programs and seek funds to provide computers and software to lend to students;
- develop lists of community based computer resources (e.g.. libraries, schools);
- involve parents in the computer education of their children;
- provide workshops for parents;
- work with computer businesses to offer discounts to parents;
- encourage parents' groups to raise funds to purchase computers for the school;
- develop a community computer equity task force;

Conclusions

If, as teacher educators, we fail to provide all students with appropriate computer education we will create a new minority - the computer illiterate. This new minority will be dysfunctional in a technological society. Equity can be achieved through a combination of equal access and appropriate learning activities.

Ignoring issues of computer equity adds yet another form of discrimination to the others present in our schools and society. As teacher educators we must raise the consciousness of pre-service teachers and encourage them to recognize and take action when they discover technological inequities in schools. Multicultural education should confront injustices rather than repeat them. Technological reform in education will bring us a step closer to providing a quality education for all students. We must prepare teachers who are capable of providing equal educational opportunities to all students regardless of sex, race, SES, ability level, or exceptionalities.

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Where are the girls? Increasing female participation in computer, math, and science education

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Computer Equity Expert Project

As we approach the turn of the century, computers are becoming increasingly commonplace in our society. They have greatly affected the way we do business, learn, and communicate with one another. Technology has become a priority in most schools, and computer labs are springing up in all kinds of educational settings. Electronic mail is a fun and efficient way of sharing with friends and colleagues throughout the nation and the world. The U.S. Department of Labor Predicts that by 1995 at least 2 million people will be in occupations related to computers and millions of others will be using computers as part of their jobs. Computer-related occupations are expected to increase by 5% per year in the 1990s, which in this economy is pretty impressive (Carnevale, 1991).

We are, however, missing a valuable segment of our population in these fields: females. Data are plentiful about the under representation of women in mathematics, science, and technology. The numbers, while improved in recent years, continue to indicate a drop-off for women as they advance on their education-to-career path. With recent attention to the unsatisfactory performance of American students in these fields, and growing concern about national economic competitiveness, the continuing drain of female talent in the sciences, mathematics, and engineering is becoming a more visible national problem. The problem, however, is not that we do not know how to increase girls' participation in math, science, and technology. It is rather that we are not doing what works: educators' focused attention on the issue and the active support and encouragement of girls to persist.

The Computer Equity Expert Project

The Computer Equity Expert Project sprang out of the need for increased awareness and action in dealing with girls' participation in math, science, and technology. In the spring of 1991, from applications of over four hundred educators, two hundred project participants were chosen. They represented every state in the country and the District of Columbia. Most teach in the schools they were proposing to work with: public and private schools, magnet schools, schools on Indian reservations, rural schools, a statewide residential school for the deaf, a statewide residential school for gifted math and science students, and a great number of ordinary elementary, middle, junior high, and high schools. The trainers, of whom 20% were male, were self-nominated and ranged from assistant superintendents to classroom teachers.

The 200 trainers attended a week-long seminar in the summer of 1991. Background sessions were taught by nationally known experts on gender equity in education; girls and women in mathematics and science; educational technology; feminist analysis of mathematics and science; and, training and presentation skills. Trainers participated in two computer equity workshops — *What is Computer Equity?* and *Computer Equity in Math and Science* — and learned how to coordinate computer equity activities in their schools with a team of faculty members, parents, and students. Trainers returned to their schools and taught the two workshops; led computer equity teams; implemented strategies to increase girls' participation in math, science, and computers; and, acted as a liaison with project staff.

Now in its final phase, the Computer Equity Expert Project has been highly successful in increasing faculty awareness of the gender gap and prompting them to implement strategies to do something about it. As a result, there are thousands more girls participating in upper-level math and science classes and computer activities than before. For many of these girls, increased interest in their grade school years could lead to highly rewarding careers involving math, science, and technology.

In order to give girls a better chance at economically and personally rewarding careers in these fields, it is important for educators, administrators, and parents alike to understand the gender gap in computers, math, and science: where it is found, its causes, and its consequences. Only then can the process of closing the gap begin.

Evidence for the Gender Gap

In the better-paying fields of computers, math, and science women are noticeably absent. While the figure is increasing, women still make up only one third of computer specialists (U.S. Dept. of Labor, 1990). As one moves into fields requiring more education, however, the numbers drop remarkably. The U.S. Department of Education reports that in 1990, fewer than 17% of the Ph.Ds in computer science were awarded to women. Engineering awarded 15.3% of its Bachelor's degrees, 13.6% of its Masters degrees, and only 8% of its doctoral degrees to women. These are fields which require higher-order math skills and advanced computer knowledge—fields which are, at the moment, not being pursued by many females.

In the elementary grades there is not much evidence of a gender gap in math, science, and technology. By the time girls reach the middle school level, however, they start to avoid the computer. The gap widens as students enter high school and increases further into college and graduate school. The only occupational areas where you will find more women than men using computers are support services such as secretarial and data entry positions, jobs which pay the least.

There is a problem: a gender gap in computer education that plays itself out in our students' working lives. All 200 trainers in the Computer Equity Expert Project had gender gaps in their computer courses, often as severe as 0:15 female/male ratio in advanced programming courses.

A word of caution, not all girls are the same. While we know that inequities exist across the lines of race, ethnicity, and class with regard to computer access and educational outcomes, studies that consider all three variables (race, class, and gender) simultaneously are few in number. Therefore, this discussion will be limited to gender and the under representation of all girls and women in computers, math, and science.

Causes of the Computer Gender Gap

What exactly causes the computer gender gap? Some argue that there are innate differences in males and females from birth and this explains the over representation of males in computer-related fields. This argument has not been proven to date, nor is it likely to be in the foreseeable future. It is impossible to raise little boys and girls in an environment free from social influences.

Very few, if any, teachers tell girls that they cannot succeed in advanced math, science, and technology classes because they are female. Most computers are not kept in a "no girls allowed" zone, such as the boys' locker room. As for teacher gender, computer gaps are found just as often in classes of female teachers as in classes of male teachers. While software can be a problem, it is becoming less of a cause of the gender gap.

The main reason for the gender gap in math, science, and technology education is also the most subtle. It is the message females receive that computers are for boys. Even as early as the first grade computers are seen as a masculine activity by most children. By the later grades, it is obvious who participates most in these fields.

Many people believe that sex bias is overt and easily recognizable. For example, it is the counselor who says, "a pretty girl like you doesn't need to take calculus" or the teacher who always gives boys the first crack at the computer. Since most teachers do not witness such events, and they know they are not doing it themselves, educators do not readily believe sex equity proponents who say that sex bias occurs all the time. It is masked by its subtlety.

Historical Associations with Computers

There are some historical associations we make with computers that have contributed to girls' avoidance of them. First of all, computers are seen as machines. Since girls are not socialized to be comfortable with machines many of them are uncomfortable around the computer. Second, computers have been largely associated with math because of their history as number-crunchers, the fact that they are associated with math classes, and that computer teachers are frequently math teachers. Past research on girls' avoidance of math has emphasized the emotional and attitudinal element of math avoidance (Sheila Tobias, 1978). Many women feel incapable of doing math and that math is not their "subject." This is not surprising since society considers mathematical ability a male characteristic and many females were not encouraged to pursue math or were discouraged from pursuing it in school. This was especially true for the mothers of today's female students—and mothers influence daughters.

The traditional, stereotypical computer culture of hackers and nerds using technical jargon or of fiery-eyed teenagers in video arcades dropping quarters in an endless stream down the throats of machines they are determined to beat have also served to further distance girls from computers. They feel alienated from groups that do not appeal to their interests. Additionally, dumb blonde jokes posted on Bulletin Board Services and widely-available pornographic software serve to insult and humiliate females.

Other Causes of the Gender Gap

Parents are also culprits of biased behavior, albeit unintentionally, when it is usually their sons rather than their daughters that they buy computers for. Families of boys are more likely to own a computer. In addition, computers are more often located in a boy's room, rather than in a neutral place for all family members. Fathers are more likely than mothers to use a computer and brothers more likely than sisters.

Adolescent girls' social lives are very important to them and peers' attitudes and expectations are influential. Being interested in computers is sometimes seen as "uncool" and girls feel uncomfortable participating in subjects and activities where their peers are absent. An example from one of the Computer Equity Trainers demonstrates this point nicely. The trainer runs a Girls' Equity Committee in the computer lab after school once a week. The 15 girls present one day were asked why they joined this club. Most of them said they enjoyed computers but were reluctant to go into the lab on their own since it was always filled with boys. Many pointed to a friend who had convinced them to come and because they liked it, they stayed.

There are curriculum factors, too: materials portraying males, violent or competitive software, projects that permit girls to be keyboarders or note takers rather than requiring them to be active and thoughtful participants. Using baseball analogies in our exercises, no matter how much we think kids love baseball, can cause confusion in girls (and boys) who don't follow sports. One of our trainers handed out a math puzzle based on baseball statistics. Whereas most boys were really excited most girls were lost. The terminology was foreign to them and, as a result, they could not understand the puzzle. They put the blame on their math ability. A database exercise using sports statistics may appeal to boys but is there something to interest the girls as well?

Years and years of research on teacher behavior patterns in the classroom have also revealed a substantial amount of unintentional, unconscious gender-biased behavior. The behaviors most commonly observed by researchers include calling on boys more than girls, accepting boys' called out answers more than girls', asking boys more interpretive questions and girls more factual ones, giving girls neutral responses ("Okay") and boys more complex responses both positive and negative, positioning their bodies toward boys more than girls, circulating more to boys' desks than girls' desks and, telling boys how to solve problems but solving the problems for girls (Sadker & Sadker, 1985).

Images of scientists and computer users as male are perpetuated throughout the media (Ware and Stuck, 1985). If you look in any computer magazine the overwhelming majority of users portrayed are male, and most often white. When a female is in the picture she is usually assisting or lending her looks to help sell a product. We rarely, if ever, see pictures in popular media of women wearing nail polish and fashionable clothes doing "scientific things"—or anything scientific that looks fun, like collecting rock samples on the top of a mountain in jeans and a tank top.

Gender bias is subtle. Single incidences may seem trivial but the cumulative power of these subtle influences no doubt causes girls to receive the message that computers are not for them. Gender bias is pervasive. We all do it. It is found in every school, in most classrooms, in many homes, even among people who consider themselves "aware." Gender bias is no one's fault. We have grown up in a society that taught us these norms and values and we learned them well. Among the media, parents, school, friends, religious institutions, and other social influences, it is impossible to spend one's life sheltered from gender bias.

The situation, however, is not hopeless. Once we understand what causes the gender gap, we can work on closing it. Through my work with the Computer Equity Expert Project I have spoken to many educators, teachers, and administrators who have successfully narrowed - if not closed - the computer gender gap in their schools.

Principles of Computer Equity

There are eight general principles of computer equity that we have used for this project (Sanders and Stone, 1986). Each will now be discussed.

Focus specifically on girls. It is usually not enough just to increase the number of computers in the lab or to open the lab up after school. If girls are not the targets of strategies they will often leave themselves out. You can include boys as well, but the primary focus should be on attracting females if you want the strategy to work. For example, you can designate free-access computer time on Tuesday as "girls' day." If you encounter resistance, designate Thursday as "boys' day" and the other three days can be co-ed. Trainers who have used this strategy noticed a sharp increase in female free-time computer use — even on co-ed days.

Target girls in groups. Adolescent girls are very social people and enjoy being around their friends. Inviting a group of friends to join a computer club will dispel fears that they are doing something seen as "uncool" by their friends. Do not show one girl something on the computer or in the science lab — show a group of girls at the same time. Several trainers saw girls' involvement peak when they worked in single-sex groups.

Design activities around girls' existing interests. To accommodate the varied interests of girls, it is important to have a wide variety of good educational software. While some girls will prefer to design greeting cards, others will be interested in writing a program to calculate average body temperature. Many adolescent girls are interested in living systems and their own bodies. A program to calculate nutrients in their diets could be very appealing to girls.

Stress the usefulness of computers. Many girls find the computer more interesting if it is presented as a tool to do their work better and faster. Charts created on a computer to illustrate a science project is an activity girls may find enjoyable.

Eliminate biased computer practices. When we unthinkingly act on the assumption that computers interest boys more than girls, we are modeling biased behavior to our students. This expectation becomes a self-fulfilling prophecy. To break this, have female computer assistants. When there is a problem with the software, ask a girl to fix it. Have a group of girls set up video equipment for class. In this way, we can begin to break out of stereotypes that pervade our society.

Pay attention to your software. Look for sex stereotyping on the screen as well as on the packaging. Look for needless violence. Often girls are turned off by blast-em-up-type software that boys seem so fond of. A collection of non-violent software is more likely to attract girls. Can the user choose to play cooperatively rather than competitively? Is the software well programmed? Frustration about using poor quality software can be transformed into active resistance if it is full of bugs or has complex directions.

Let others know. When you find something that works particularly well in your classroom or school let other faculty know so that they can try it too. Bring up successes and failures at faculty meetings or in casual conversations with colleagues. Discuss your activities with administrators and let them know what has worked for you.

Do it again next year. Only through continued efforts can gender bias be eliminated from our classrooms. Systematic change is a slow process which requires commitment and dedication over time.

What Works

Below are two lists of strategies compiled from interviews with the Computer Equity Trainers. These strategies have been tried and found to be useful in getting girls more involved with computers, math, and science.

Simple Strategies

Some strategies, as trainers found, require nothing more than a committed effort on the part of one teacher. They can be tried in your classroom tomorrow.

- Call on girls more.
- Choose a girl as a computer assistant.
- Do not permit sexist materials, "jokes" or behavior in your classroom.
- Notice the girls who hang back and pull them in.
- Encourage girls to participate in computer clubs and open labs in peer groups.
- Encourage talented girls to continue in technology.
- Emphasize women in technology careers

Pay attention to these picky and seemingly trivial things and you will see results. A trainer from Colorado reports that female enrollments in AP Chemistry increased 14% since the new chemistry teacher started personally inviting and encouraging girls to take his class.

Strategies Requiring More Effort

While these strategies require more planning and funds, they have successfully served to increase girls' participation in computers, math, and science.

- Educate parents about technology for their daughters. Speak at a PTA meeting on the importance of encouraging females to take more math, science, and computer courses and to develop their skills in these areas.
- Have a special time set aside for girls in the computer lab, e.g., Thursday lunch time. Invite them to bring their lunch, socialize, and work on the computer. You don't have to exclude boys, but if it is advertised right and girls are offered personal invitations, watch who shows up.

- Hold a girls' technology night at school. Invite parents to explore technology and technology careers with their daughters. Provide refreshments, such as pizza and soda. Have girls demonstrate the equipment.
- Produce a video yearbook as one trainer from Kansas did with 25 junior high school girls. The group met for one hour each week for eight weeks. They learned how to use the hardware, software, VCR equipment, and cameras. The tapes were sold for $10, leaving the club a profit of $7 on each tape!

There are many creative strategies being used by trainers too numerous to list here. The point is, however, it's not always what you do that matters — just that you do something.

The Project Continues

The Computer Equity Expert Project will officially end in February of 1993. However, the project will live on indefinitely through many of the 200 trainers who have diligently worked with students, faculty, administrators, parents, and others to get more girls involved, to raise the consciousness of all toward equity issues, and to create a more equitable environment for all students to learn in. Each trainer reached an average of 50 other faculty members and 350 girls with their equity message and activities. Although project responsibilities were many, 84% of the trainers did more than the minimum requirement of teaching two workshops — they also carried out other strategies with girls. In addition, 43% of the trainers did an outstanding job involving students, staff, and often administrators with their equity activities. Furthermore, trainers' equity activities did not stop with their schools: Over three fourths of the trainers have been involved with presentations, workshops, and other equity activities beyond their immediate faculty. These equity activities were conducted at conferences, board meetings, PTA meetings, in other districts, other schools, and organizations such as the Girl Scouts and the American Association of University Women.

Quite surprisingly, despite the activity and expertise demonstrated by the majority, few Computer Equity Trainers were exposed to issues of gender equity in education before participation in this project. Even 17 years after Title IX became law, faculty members in schools interested enough in applying to participate in the project were unaware of the extent to which females were underrepresented in math, science, and technology education and careers. They were unaware of the research on classroom interaction patterns and had not thought about the cost to society and to women in general when women do not acquire the skills necessary for technical and scientific careers. They were unaware of the many strategies to combat and reverse girls avoidance of these fields. Through reading evaluations of trainers' workshops in their schools, the project staff was surprised that a common theme running through the reactions to the material presented was, "I had no idea things were like this."

Although this project has worked basically through inservice training and staff development programs, we see the need for training of this kind in teacher preparation programs. Conversations with many prominent teacher educators yielded the conclusion that gender equity is generally not included in courses taught to pre-service teachers. This is a problem we hope to address soon.

In the political arena of 1992, the year of change, education is a major topic. Education has been charged with the responsibility of preparing our nation's youth to build, maintain, or perhaps regain the country's economic strength. Much focus has been put on math, science, and technological skills as the way to achieve this goal. As we strive to better prepare our students for a changing world, a technological world, it is important not to leave behind one-half the population: females. Women are entering the workforce in increasing numbers and the percentage of women working who have children under the age of one continues to rise. Not all working mothers do so by choice—usually it is an economic necessity. Many of these women will be single mothers, the sole economic support for their family. This fact has not hit many of our female students yet. We must prepare them to face this reality.

Not all educational progress needs to be a lengthy, thought-out, dramatic process. It does not have to be continually evaluated by administrators or specialists with Ph.Ds. It does not have to be a directive from the school board, superintendent, or the principal. Educational progress can come directly from one concerned individual. That person could be you.

The Computer Equity Expert Project is funded by the National Science Foundation, IBM Corporation, Hewlett Packard, Intel Foundation, Xerox Foundation, American Express Foundation, Chevron, and The Westinghouse Foundation.

I wish to express my sincere thanks and gratitude to the project director, Jo Sanders, for her comments on this paper.

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Technology and language minority students: Implications for teacher education

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There are approximately 2,000,000 Limited-English-Proficient (LEP) students attending public and private schools in the United States (OBEMLA, 1991). This number is expected to reach 3.4 million by the year 2000 (Oxford-Carpenter, Pol, Lopez, Stupp, Gendell, & Peng, 1984). California has the greatest concentration (approximately 862,000) of these students in the nation (CSDE, 1989). The multilingual, multicultural immigrant population of the state's Central (San Joaquin) Valley represents a microcosm of the state. Its largest school district, Fresno Unified, reports that 89 different primary languages are spoken by its students and nearly one third of its students qualify as LEP (Fleming, 1992).

Computers and other technologies which provide students with visual and audio support are effective means of helping language minority students develop their language abilities. Rosebery, Warren, and Bruce (1989) report that the Macintosh computer is particularly well-suited to LEP students. Its graphical user interface and object-oriented programs, such as HyperCard, allow these students to become skilled computer users as quickly as native speakers of English. Further, they have found that this ease of use means "students can engage in problem solving that is conceptually appropriate to their intellectual abilities rather than problem solving that is limited artificially by their proficiency in English" (p. 265).

Unfortunately, national reports indicate that fewer than 25% of the teachers serving LEP students employ computers in their teaching (Johnson, 1985; NSBA, 1991). We have recently completed a three-phase study which determined the extent to which computer-based technologies were available and used to develop and enhance the language skills of language minority elementary school students within California's Central Valley.[1]

Design of the Study

School districts within the region were categorized by the percentage of LEP students in their student population, 0-10%, 11-15%, 16-25%, and greater than 25%. A stratified random sample of twelve districts was chosen and personnel within each district office were contacted regarding the study. All twelve districts agreed to participate and identified an elementary school which represented their district's student population in terms of percentage of LEP and the languages spoken. Survey data were gathered from the district office personnel and the principal and teachers at the selected school.

In addition to demographic information about their student population participants were asked about their access to technology, how they modified instruction for language minority students, under what conditions their students used computers, and the support they received to assist them use technology with language minority students.

Approximately 20% of the teachers who returned the surveys were chosen for interviews. This selection was based upon a categorization schema which considered the primary languages spoken (predominantly Spanish or from a wider range) and whether computers were used primarily in a school lab or individual classroom settings.

The final phase of the study involved making observations in classrooms. Because we wanted to see language minority children interacting with technology, schools selected for visitations were those in which the teachers indicated they were using computers and other technologies with their LEP students.

Findings

Most of the teachers who returned surveys reported that they modified their instruction to help their language minority students. The most commonly listed methods were using bilingual classroom aides, grouping students by language ability, teaching in the primary language, and using sheltered English strategies such as preview/review. *None* of the instructional modifications were technology based.

Despite the fact that approximately half of the teachers participating in the study (N = 177) had regular classroom access to computers, 60% *never* used computers with their language minority children. Those who indicated that their language minority students used computers primarily had their children work individually or in pairs using language arts or mathematics drill and practice software.

Even in schools where computers were more widely used, teachers reported a very limited range of instructional strategies and activities. The computers were used most often for drill and practice in basic skills; however, one of the schools visited had focused their computer technology and energy towards the establishment and operation of a school publishing center.

When the non-computer-using teachers were asked why they did not teach with technology, they cited a lack of resources and training. This finding concurs with the Office of Technology Assessment's (1988, p. 87) conclusion that "Barriers to [teachers'] use are both practical (inadequate access to the technology) and intellectual (initial fears of using the technology and a lack of understanding of the computer's value in serving the curriculum)."

Implications for Teacher Education

Though lack of equipment continues to be a problem, too often the existing equipment goes un- or under-used because teachers are not aware of how technology can enhance their teaching and student learning. This lack of awareness has policy implications for teacher educators. First, teacher education programs must model the effective use of technology within **all** their courses (not just the "computer course"), arrange field experiences in which students can see technology being effectively used, and ensure that their graduates have opportunities to demonstrate proficiency in using technology as a tool for productivity and instruction.

Secondly, teacher educators must promote equitable access and use of technology. Too often those students who are fortunate enough to have contact with technology are required to participate in drill and practice exercises rather than in activities which offer opportunities for students to develop their language and critical thinking skills. Teacher educators must show students how technology can be used to promote natural, realistic language acquisition and remind their students that just because kids cannot speak English fluently does not mean they cannot think critically.

Notes

1. "Limited-English Proficient" or "LEP" is the designation on which government reports are based. The authors prefer to use the term "language minority" to describe those students whose primary language (the language spoken in the home) is other than English.

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Anxiety, confidence, and attitudes toward computers among limited English proficient middle school students: Implications for teacher educators

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In the United States, the minority group that is most highly under-represented in computer science participation is the Hispanic population (Oakes, 1990). Sanders and Stone (1986) suggest that the outcomes of computer avoidance have adverse effects on individuals as our society becomes increasingly technological. Hence, it is important that factors contributing to the lack of representation among Hispanics be investigated. Oakes' findings (1990) suggest that socioeconomic factors are minimally responsible for low participation in computer courses. In a study comparing various racial groups among college students, Badagliacco (1990) found that Hispanics have the least favorable attitudes toward computers and do not appear to perceive computers as an instrument for upward social mobility. These attitudes may contribute to the lack of computer science participation among Hispanics and likely develop during the early years of school. The purpose of this study was to determine the computer anxiety, attitudes, and confidence levels of Spanish-speaking limited English proficient (LEP) students who are at the upper elementary and middle school level.

Methodology

The *Computer Attitude Scale (CAS)* (Loyd & Gressard, 1984) has been used widely over the past eight years to assess students' levels of computer anxiety, computer confidence, liking of computers, and perceptions of the usefulness of computers. The subscales of the instrument have coefficient alpha reliabilities ranging from 0.76 to 0.89.

For minority students, especially those with limited English proficiency, it is important to investigate anxiety, confidence, and attitudes in the students' language of greatest proficiency; in many cases, that is their native language (Cummins, 1989; National Coalition of Advocates for Students, 1988). The original *CAS*, therefore, was translated into Spanish. The new instrument, the *Computer Attitude Scale in Spanish (CASS)*, was revised and verified as accurate by four independent, native-Spanish-speaking judges.

The *CASS* was administered to 219 LEP Spanish-speaking students (grades four through eight) from both rural and urban areas in Central California. Students were asked to respond to the 40 items on the *CASS* and to also estimate how many times they had previously used a computer for word processing, programming, spreadsheets, databases, and recreational applications. Finally, students were asked to indicate their date of birth, grade level, and sex. The data from 42 of the subjects (primarily fourth-graders) were discarded due to incomplete, excessive, or inappropriate (e.g., answers formed a pattern like a-b-c-d-c-b-a...) responses.

Mean scores on the four subscales—computer anxiety, computer confidence, student liking of computers, and perceived usefulness of computers—were calculated and compared to the norms reported by Loyd and Gressard (1984). Two-way ANOVAs (Age x Sex) were calculated for each subscale score. Descriptive statistics were calculated for the items measuring the students' use of computers.

Results

Computer anxiety in the LEP group was comparable to that in the norming group (see Table 1). The LEP students did, however, show slightly lower confidence and much lower perceptions of usefulness and liking of computers than the norming population. It is interesting to note that the standard deviations for the LEP subjects were generally lower than the norming group, except for the Usefulness subscale. There were no significant differences in the subscale scores by sex or by age for the LEP group.

As shown in Table 2, students reported having had many more experiences using computers for recreation than for word-processing, programming, spreadsheets, or databases.

Because Badagliacco (1990) suggests that Hispanics do not perceive computers as an instrument for upward social mobility, individual *CASS* items relating perceptions of future relevance and usefulness of computers were analyzed (see Table 3). Over 62% of the students agreed to some extent that they expect to have little use for computers in their daily lives. Over 42% agreed that they can't think of ways to use computers in their careers and over 45% agreed that working with computers will not be important to them in their life's work. One-fourth of the subjects felt that computers were a waste of time and about 23% responded that computers were not worthwhile. (One indication of the reliability of the data is the consistency of students' ratings of two oppositely-worded items relating to whether learning about the computer is worthwhile versus a waste of time.)

Discussion

While middle-school-aged Hispanic students do not have greater computer anxiety than the norming population, their confidence and attitudes are less positive. The fact that most of the computer experiences for this group have been in the area of recreation may explain why their computer anxiety is relatively low.

The lack of gender differences in anxiety, confidence, and attitudes supports the findings of Badagliacco (1990) who noted that the typically more positive affect of males toward computers may be washed out by the reported perceptions of Hispanic students that computers are "feminine." She suggests that this may be due to the fact that the generally-used word for computer in Spanish is "computadora," a feminine noun.

The fact that these students think learning about computers is useful but not important in their future careers suggests that these students have not yet been

Table 1.
Comparison of Subscale Scores on the *Computer Attitude Scale in Spanish (CASS)* and the *Computer Attitude Scale (CAS)* by Limited English Proficiency and Norming Population.

Subscale	**LEP Students (*n* = 172)**		**Norming Population**	
	Mean	**Std Dev**	**Mean**	**Std Dev**
Anxiety	32.19	4.55	32.1	6.1
Confidence	30.28	5.34	31.3	5.6
Liking	30.78	4.77	33.3	5.4
Usefulness	29.49	4.78	33.9	4.1

Table 2.
Students' Reported Previous Computer Experiences

Application	**Never**	**1-10**	**11-20**	**21-30**	**> 30 times**
Word-processing	53.5%	34.3%	4.7%	4.7%	2.9%
Programming	73.7%	14.6%	5.3%	5.3%	1.2%
Spreadsheets	81.9%	11.1%	4.7%	1.8%	0.6%
Databases	84.2%	7.0%	5.3%	3.5%	0.0%
Recreation	39.4%	22.4%	12.4%	13.5%	12.4%

n = 172

Table 3.
Student Responses on Selected Statements on the CASS

Statement	Strongly Agree	Slightly Agree	Slightly Disagree	Strongly Disagree
1. I expect to have little use for computers in my daily life.	48.8%	14.0%	15.7%	21.5%
2. Learning about computers is worthwhile.	61.0%	15.7%	4.7%	18.6%
3. Learning about computers is a waste of time.	19.4%	5.3%	6.5%	68.8%
4. I'll need a firm mastery of computers for my future work.	52.0%	14.6%	14.6%	18.7%
5. Knowing how to work with computers will increase my job possibilities.	72.6%	12.5%	5.4%	9.5%
6. I can't think of any way that I will use computers in my career.	24.7%	17.6%	14.7%	42.9%
7. Working with computers will not be important to me in my life's work.	31.1%	14.4%	10.2%	44.3%

n =172

exposed to ways in which computers can be used for higher level skills such as the analysis of information. This assertion is further supported by the small number of reported uses of computers beyond recreation and word-processing.

It is also interesting to note that while a large majority of these students responded that learning about computers increases job opportunities, many fewer students suggested that they would use computers in their careers. This suggests that there may be a large difference in the students' perceptions of computer use for "us" versus for "me." Although they expect that computers can help others they do not perceive that they will be personally helpful to them. This finding also supports the data from Badagliacco (1990), who found in her non-computer group a relatively high rating among Hispanic students on how useful computer experience would be in getting a job compared with the rating on how helpful it would be to them in their line of work.

Implications for Teacher Educators

These findings have several implications for teacher educators. If computer equity is to be attained, then preservice computer instruction must not only give computer skills to future teachers, but it must also include methods for modifying the attitudes and beliefs of LEP Hispanic students. Suggested instructional strategies include the following:

1) Using role models to show students the relevance of computer knowledge for their careers (e.g., inviting Hispanic individuals to speak to the students or showing films or videotapes of well-known Hispanics who use computers and can show the importance of computers in most professions);
2) Using computers in ways that show applications to daily life (e.g., usefulness in problem solving and decision-making processes through the use of databases and spreadsheets; usefulness for creating things such as signs or banners using *Print Shop* or another utility program);
3) Using cooperative groups during students' first experiences in using computers in order to establish a supportive atmosphere (It is important that the groups use true cooperative strategies by making sure that all students are involved in the total group process);
4) Using Spanish-language programs to improve LEP Hispanic students' success rate in overcoming language difficulties. While there are a limited number of programs available in Spanish, it would be important to have Spanish characters available for word-processing, databases, etc., and to provide instructions in Spanish for some of the programs (e.g. *La Frabriqua, Kid Pix).*

Finally, it is important that pre- and in-service teachers be made aware of the difficulties that second language students face, the factors behind their historical under-representation in using computers, and the importance in a democratic society of facilitating a change in their students' attitudes about the relevance of learning to use computers.

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Multimedia personal Computer based second language acquisition: New fantasy or old vision?

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For over thirty years, attempts have been made to utilize computers to teach or enhance the acquisition of a second language. During the past decade, much of this effort has involved the use of personal computers in the classroom. For the most part, attempts at Computer Assisted Language Learning (CALL) have experienced only limited successes, generally confined to learning the rules of grammar and vocabulary building. The delimitations to success are due both to the nature of the constraints presented by available computing environments and to the lack of an efficacious pedagogy (Ahmad, Corbett, Rogers and Sussex, 1985; Young, 1988; Smith, 1989; Dunkel, 1991; Garrett, 1991).

The theories and instructional approaches to second language acquisition have been subjected to debate over their content and objectives in a similar manner as CALL (Pennycock, 1989; Grittner, 1990; Herschensohn, 1990). The dominant approaches are characterized by their emphasis on the development of communicative proficiency and the presentation of language learning experiences in the context of the target language culture.

The Multimedia Personal Computer (MPC) will allow students to be engaged in real-time, "interactive dramatizations." These simulations of natural language learning experiences will be designed with a sense of reality that has never existed in the past and will incorporate essential elements of second language acquisition theory. MPC machines will feature CPU's with access speed, laser-mediated data storage capabilities, and compression techniques to accommodate digitization of video and animation, high quality audio effects, sophisticated speech synthesis, and independent speech recognition. All of these functions will be integrated and directed by artificial intelligence to correctly respond to conversations by the student through natural language processing (Underwood, 1989).

Students will be presented with recreations of social situations from the target language culture that will coalesce the MPC's capabilities to create a sense of realism that evokes reactions. The sequence of scenes that appear and the conversational responses of the characters in them will be immediate consequences to the student's discourse. The result will be to transport the student to a pseudo-reality that will encourage language learning as a function of the illusory experience.

Computer Assisted Language Learning and Multimedia Personal Computers

Computing applications are extending into distinctly new environments almost as quickly as new platforms and technologies emerge. Interactive dramatizations are the ontogeny of the evolution of electronic instructional media for language acquisition.

Although the use of wire and tape audio recordings, film strips, video tape, video discs, and computer-assisted instruction (CAI) may not have met expectations for improvement of student performance it has resulted in an accumulation of empirical research findings. The concept of interactive dramatization capitalizes on observations derived from antecedent instructional media experiences and is the hybrid of two approaches, interactive video and simulations.

Wyatt (1989) identified three CALL categories — instructional, collaborative, or facultative — comprising fourteen different types of programs. Instructional programs were characterized as presenting language learning information in a predetermined fashion. Collaborative programs were not predetermined and required students to draw from their own resources. The central issue of determination is control. Predetermined tutorials/drills reduce the student to a passive respondent. Interactive programs allow the student to influence the sequence of events. Lucas (1992) observed that in interactive situations, both the computer and the learner are actively responding to information and adapting to responses. The value of interactivity becomes especially prominent as a function of simulations.

An integral element of second language instructional theory is the importance of the context of the learning experience. Simulations, attempts to involve the student in recreations of meaningful real-life situations, are commonly employed to provide contextual reality in language learning classrooms. Simulations range in complexity from simple dialogue exchanges to elaborately designed scenarios. The most critical feature of a simulation is the extent to which it approximates reality. The student's willingness to accept the illusion as a credible reality affects the likelihood of the student attempting to engage in a range of authentic conversation tasks.

The synergism from the application of the capabilities of the computer to the simulation format offers a potential for language learning that is significantly different from that which is available in existing CALL programs (Crookall, Coleman and Versluis, 1990). Simulations using video tape or video disc are limited by their dependence on keyboards or touch screens rather than natural discourse as the basis for the interaction. Students using scripted simulations are hampered by the confines of the classroom milieu and the absence of native speakers to act as models. The virtue of the MPC based interactive dramatization is that it will combine the human interaction of classroom simulations with visual and audio realism in a controlled lesson that is dependent on the student's responses. In interactive dramatizations students will converse as active participants in authentic social situations designed around specific uses of the target language. The consequence of the student's responses will be immediately evident to the student. The distinctions in grammar, semantics, and phonology will be more meaningful when the distinctions become the basis for the enactment of scenes different from those anticipated by the student.

The dramatizations will supply the discourse with true contextual relevance and meaning by accompanying them with behaviors that naturally occur in the target language's culture. Language use is a culture-bound experience with behavioral dynamics " and operating realities" that can't be taught in a classroom. (Ruben and Lederman, 1990). Young (1988) points out that learning the rules for participating in conversations can only happen through actual participation. Simulations can be organized to elicit "strategic interactions" that purposely use the target language (Di Pietro, 1987) while supplying comprehensible input to the student (Altman, 1989).

Pedagogical Considerations

The establishment of a single, acceptable, comprehensive pedagogy for CALL is not a reasonable expectation (Bialystok, 1990; Hatch, Shirai and Fantuzzi, 1990; Herschensohn, 1990). The four basic components inherent to CALL are the student, the computer platform, learning theory, and language acquisition theory. Evaluative research identifying the interactive effects of the components in a commonly shared language learning milieu should be the basis for the design of a variety of effective approaches.

Too often in the past, students were perceived as an unitary subject. An effective understanding of students requires an examination of their "user requirements," both in an academic and a computing sense. Students enter second language classes at different ages, displaying different intellectual abilities, and have different motivations for learning a new language. They also have different literacy skills in their native language and cultural values that may vary. In addition, the students have different experiences, skills, and comfort levels with electronic instructional media. If the lesson is to be student centered, both the affective and cognitive characteristics of the student have to be considered as the focus for the lesson. Lucas (1992) believes that the effectiveness of interactivity results from matching the desired learning outcomes with the learner's abilities.

An array of linguistic phenomena have to be consolidated into an approach that lends itself to instructional applications that are appropriate to the functions of the multimedia personal computer. This approach cannot be designed to merely utilize the computing conditions, it must demonstrably enhance the acquisition of the second language. There is a tendency to be overly concerned with the technical features (bells and whistles) of the computer at the expense of the software program. Hannafin, Garhart, Rieber and Phillips (1985) have cautioned against allowing the focus of the design to be on the electronic media's capabilities rather than on instruction. The instructional design should, nevertheless, consider how to derive the maximum benefits of the capabilities to augment the instructional experience. Under what conditions are the characteristics of the computer/software the most effective means of instruction? What are the curricular objectives and learning circumstances best suited for a specific implementation? Are the hypotheses associated with the design of the program valid and are they incorporated into the lesson's methodology?

The number of prominent and contradictory language acquisition theories, and the centuries-old debate about their relative merits, reflects the complexities and mysteries of the task. However, a communicative approach that prepares the learner for real world experiences appears to have the most support for use in second language instruction. Interactive dramatizations will encompass the basic tenets of the communicative approach: use of the target language in a cultural context, meaningful input, active involvement of the learner, and the freedom to safely make mistakes. Personal involvement in the dramatizations should create the social and affective characteristics that contribute to the learner's "psychological proximity" to the target language (Harley, 1986).

Using multimedia to approximate interactive conversations in the natural setting of the target language—real human activities and events—can provide students with comprehensible input in a way that is interesting and motivates the student to communicate. Yet, unlike the natural experiences, the dramatizations can be designed to intentionally accommodate language acquisition theory and cognitive learning theory involving analytic processes, restructuring, and the consolidation of learning that leads to mastery (Shulz, 1991).

The acquisition of communicative proficiency is more likely if the student is presented with an implicit approach including authentic oral language modeling and a visual cultural context. The presentation of basic language problems embedded in the dramatizations in a systematic way will encourage inductive language learning (Titone, 1984). The frequency or exposure to relevant structures and opportunities for meaningful practice of specific factors (Harley,1986) can be controlled. The characters of the dramatizations can furnish implicit correction to the learner, decrease the anxiety normally associated with explicit correction, and elicit further attempts at speech and the elaboration of thoughts in the target language.

Schuman (1978) believes that "pidginization", reduced or simplified speech, occurs as the result of reduced contact with native speakers. Hammerly has expressed similar observations about classroom immersion programs (1989). His concern is that the immersion classroom, with only the teacher as a native speaker, is not a sociolinguistically natural environment. He further indicates that discussions with other non-speakers can lead to minimal mastery of the target language once the students become successful in communicating to each other with minimal proficiency. Both concerns are related to the fossilization of speech skills in the second language that is observed in older non-native speakers without formal instruction. Interactive dramatizations have to be designed with increasing levels of demand for linguistic complexity appropriate to the student's needs and abilities and increasing rates of speed for the conversations.

The multimedia personal computer will present processing capabilities, beyond the dramatizations, that will increase the value of the lesson. Discourse analysis of the grammar—syntactic, semantic, and sociolinguistic skills that the student employs in the dramatizations can be used to insure that the comprehensibility of the computer generated speech is appropriate to the development of the student. In addition, the types of language learning strategies that the student attempts to use, including their sophistication and success rates, can be provided for the teacher. This information can be used to record progress and make decisions about specific objectives of future lessons.

Although grammar translation is no longer the primary objective for second language acquisition, directed grammar instruction and practice is still needed to explain communication and provide a framework for future acquisitions. A classroom syllabus for formal grammar instruction to accompany the interactive dramatizations must be available to the teacher and the student.

Conclusion

There is an immediate need for formal evaluative research of the effects of computer assisted language learning that is based on emerging multimedia personal computers. Researchers should determine what aspects of instructional media enhance the acquisition of a second language and under what conditions is it most effective in doing so. Earlier and existing attempts in CALL have clearly demonstrated that without an efficacious model for the design of software, the benefits of the instructional experience are often specious. The capabilities of the multimedia personal computer that will be commonly available before the end of the decade will rival what had been mainframe technology and make large scale language learning programs like the Athena Project (Morgenstern, 1986) available on the classroom desk.

A pedagogy based on the applicability of validated hypotheses from learning theory and second language acquisition theory should be the basis for the design of language learning programs for the multimedia personal computer. The assumptions and conditions of the program need to be verified and applied to instructional strategies that have been proven to be successful in language learning. A reliable assessment of the student's affective and cognitive characteristics needs to be incorporated into the programs to provide individualized direction to the learning experience.

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Using multimedia to teach social foundations in an urban teacher preparation program

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Those who cannot remember the past are condemned to repeat it.

—George Santayana, 1905

The preparation of teachers is arguably one of the most important responsibilities of a society. If we teach our teachers well, they, in turn, will teach our children well. In this way a mechanism is established whereby a society can grow and advance. An understanding of the historical, philosophical, psychological, and social foundations of education has traditionally been essential to this preparation (Shulman, 1990). Without this understanding other components of teacher preparation such as methodology or technology do not have a focus or purpose. To develop an understanding of educational foundations, however, teacher educators must rely on methodology and technology to be effective. In sum, educational foundations, methodology, and technology should be dependent upon and integrated with one another in a teacher preparation program.

The purpose of this paper is to examine the use of modern methodology and technology in teaching social foundations in an undergraduate teacher preparation program. Specifically, this paper presents the use of "The Five Points: A Multimedia Experience in Social History" to teach social issues and group conflict in Hunter College's QUEST (Quality Urban Elementary Student Teachers) program. "The Five Points..." re-purposed a highly-acclaimed videotape produced by the American Social History Project of the City University of New York. The original videotape was designed to teach social history which focuses on the lives of ordinary citizens and common folk more so than on presidents, world leaders, and kings or queens. The new program is videodisk-based and utilizes an IBM PS/2-70 microcomputer and a Pioneer LD-8000 laser disc player. The software is Asymetrix's Toolbook authoring language with the Multimedia Extensions. It is hoped that the description provided here will be useful to others planning or developing similar multimedia materials.

Social Foundations and the Urban Environment

Educational foundations is usually integrated into a teacher preparation program to provide some of the history, philosophy, psychology, and sociology which undergirds education. In an urban teacher preparation program the development of an understanding of major social themes such as minority issues, stereotyping, and group conflict are particularly critical to the teaching of educational foundations. These issues are as significant in American cities today as they have been for the past two hundred years.

In developing an understanding of these themes, future teachers must also come to understand their own attitudes and sensitivities about other social groups. In New York City, as in many other American urban areas, a new wave of immigration is rapidly changing and creating a dynamic social make-up which governmental leaders such as David Dinkins and Mario Cuomo refer to as the "gorgeous mosaic." To be successful, teachers in urban America have to be sensitive to the social needs of all children regardless of color, language, religion, or customs.

The development of "The Five Points..." was designed to help future teachers develop an understanding of, and sensitivity to, the multicultural social needs which exist in today's classrooms. To accomplish this, an obscure event which occurred on July 4th, 1857, is used as a case study in group conflict. The event involves a riot which killed twelve people and injured hundreds. It involved Irish Catholics, who at the time were New York City's largest minority group, several street gangs, and the newly-formed Metropolitan Police Force. The three major learning objectives of "The Five Points..." are:

- to motivate students to be sensitive to and considerate of minority group issues and how they can contribute to conflict;
- to inform students of the historical nature of group conflict as a complex interaction of social, political,economic, and cultural forces;
- to involve students in an activity wherein they can explore and develop their own ideas and opinions of social group conflict and its causes.

These are sensitive issues in American society and, at times, difficult to discuss. However, they cannot be ignored and as educators we need to develop methods and approaches for discussing and teaching about them.

Conceptual Design and Pedagogy

The original "Five Points" videotape was designed to be used as a sequential, structured activity. An instructor would show the tape and stimulate discussion as important segments were shown. The videodisk-based version was designed to be an unstructured, discovery learning activity which would be appropriate for use by individuals or small groups. The concept of discovery learning is not new and is based in part on Jean Piaget's theories of experiential learning. Applying discovery learning to technology, likewise, is not new. Seymour Papert (1980), among others, used it as the conceptual basis for the popular Logo program which is used in thousands of public schools across the country.

Critical to a successful discovery learning activity is the need to develop student interest and curiosity so that they want to learn and "find out" about a subject. Discovery learning should also allow students to experience a subject. In laboratory sciences such as physics, chemistry, and biology the concept of discovery and experiential learning is integral to the entire study of these subjects. A classic project in physics might involve having students build a miniature vehicle which can travel a certain distance under its own power. In building their vehicles, students learn about the physical properties of materials such as metals, wood, or plastics. In developing a power source, students might learn about solar energy and friction. The completed vehicle represents the "finished product" of a whole series of learning activities. In teaching about an historical event, similar concepts of discovery and experiencing can also be applied.

Teachers of history and the social sciences tend to rely extensively on text and the written word. However, video technology can allow students to go beyond reading and writing. "The Five Points.. " was designed to have students become involved with and experience an historical event. To do this, students become reporters for the New York Daily Tribune. The date is July 6, 1857 and their assignment is to write a feature article on the real causes of the riots which had occurred on the previous weekend. To complete their assignment, students can hear eyewitness accounts, see photographs and sketches of the events, keep a notebook, visit an archive room, and write their article within "The Five Points..." program. Just as the finished vehicle represents a culmination of learning activities for the physics students, the completed article represents the same for our reporters. However, the hope is that by seeing, listening, and reading the students have become involved with the event and its component parts—especially the people and societal issues. In keeping with the principles of discovery learning, students also have choices as to what they see, hear, or read. They can also pursue several themes for their articles.

"The Five Points..." is also designed to keep students interested by appealing to several senses. In addition to reading and writing activities, the program provides sketches and photographs which are colorful and interesting. The dialogue of the eyewitnesses is provocative and spoken with accents and in street language appropriate for the period. Background music is used to set a mood. College students of the 1990s have been inundated with images and sounds from television and music videos for most of their lives. They relate well to this mode of receiving and collecting information. The designers of "The Five Points..." subscribe to an approach which posits that educators at all levels should probably be making greater use of multi-sensory techniques for delivering instruction.

It should be emphasized, as a final comment, that

"The Five Points..." program was meant to go beyond the basic database and simpler tool uses of multimedia technology which are becoming prevalent. To a degree, the program was designed to be closely integrated with teaching and learning and to provide a mechanism wherein students can become interested in, involved with, and motivated to learn about a topic on their own.

Description of the Program

"The Five Points..." uses twenty-five minutes of video from the original videotape program. Approximately one hundred additional photographs and sketches were included to fill thirty minutes or one side of a videodisk. The program also provides a variety of source materials such as maps, charts, and documents which are stored on magnetic disk. The program is organized into five major components:

1. an introduction to the program;
2. eyewitness accounts;
3. an archive room;
4. draft of article;
5. relating student interpretations to the present.

Each of these components plays an important role in achieving the program's learning objectives.

Introduction to the Program

The introduction is specifically designed to arouse curiosity and interest in the topic. A series of nine "tease" clips of approximately seven to nine seconds in length are shown that describe the "mayhem" which occurred on July 4th in "our heaven- blessed" city. A quote from Charles Dickens also is part of the opening segment which refers to the Five Points as "loathsome, drooping, and decayed." The introduction can be compared to the first chapter of a mystery novel. It attempts to arouse the reader's interest enough to want to know more about what happens or "who done it?"

Following the tease clips, an actual reproduction of a headline from the New York Daily Tribune on July 6, 1857 is shown. This further describes the riot in the "notorious" Five Points section of the city. "Twelve People Killed" reads the headline. The accompanying article attributes the riot to the reaction of Irish Catholics to the State's recently enacted Liquor Excise Law which, among other things, closed the "saloons" on Sundays. Among other things, this headline represents the stereotyping of Irish Catholics as drinkers which was prevalent in the 1850s.

The introduction concludes by asking the student to take on the role of a reporter who has to write a feature article on the "real causes" of the riot. At the reporter's disposal are a list of eyewitnesses, the newspaper's archive room, and a notebook.

Eyewitness Accounts

The eyewitnesses to the riot are the Mulvahills, Tom McKivigan, and the Reverend Louis Pease. Initially, the student reporter can access only five clip buttons, all of which comment specifically on the riot but also provide hints of other issues such as politics, culture, and overall social conditions. These clips can be accessed in any order and can be played repeatedly. The reporter can also send a message to the editor-in-chief of the newspaper indicating that the eyewitnesses have been interviewed and that he or she is ready to write the article. Because the story of the riot is "heating up," the editor suggests that the eyewitnesses be interviewed again.

At this point, twelve more clip buttons, approximately thirty seconds to four minutes in length, are made available. In these clips, the eyewitnesses describe living conditions in the Five Points. The Mulvahills are Irish Catholics who are trying to make a life for themselves. Tom McKivigan is a volunteer fireman who knows the importance of helping local ward bosses at election time. The Reverend Pease is a Protestant minister and social reformer who runs a mission in the neighborhood and sees the sad conditions of abandoned children, prostitution, and too much liquor "coursing through the Points."

After viewing these clips three more clip buttons, described as "Off the Record" comments, are made available. In these clips, several eyewitnesses make informal comments about other eyewitnesses. This confronts students with the conflicting nature of different perspectives.

The Archive Room

An important feature of the multimedia program that was not available in the original videotape is the archive room. This room is a Toolbook page that depicts a reference room or office from the 1850s. Old-fashioned desks, oil lamps, and a grandfather's clock reinforce the pseudo-reality that the reporter is in 1857. The archive room provides a series of doors; drawers;and, books labeled Source Documents, Maps, Charts, Dictionary, Who's Who, and Editor's Memoranda. Within each of these is a list of Toolbook hot words which can be activated to provide mostly text information on the topic.

The archive room adds significantly to the multimedia program for several reasons. First, it provides a change of pace from the narration and video material and helps the student reflect on what he or she has heard from the eyewitnesses. Second, it provides the student with a research experience. They can explore or discover the meaning of new words and places as well as verify information they are receiving from the eyewitnesses. Third, as stimulating as video and audio material can be, the archive room reinforces the importance of text, statistical tables, and other material that are meant to be read.

Draft of Article

The benefits of a written exercise cannot be overstated if one wants to understand attitudes to sensitive subjects. In addition to a teacher learning about students' attitudes, the students, as they put their thoughts to paper, can come to examine their own attitudes. As an open-ended exercise, writing also provides students with the opportunity to explore and consider various possibilities.

The program provides two separate features to help the reporter develop their article. A Toolbook text field which can be accessed at anytime during the program functions as the reporter's notebook. Although the program originally provided "cut and paste" features common in many authoring languages a decision was made to require reporters to compose their own notes. The rationale here was that this would slow down the activity and provide opportunities for students to reflect on the material. It would also yield more insight into a student's thoughts. A second Toolbook text field on a separate page functions as draft paper for writing the article. To gain access to the "Draft of Article" page a reporter must view at least seventeen of the twenty clips. If the student attempts to draft the article prior to viewing seventeen clips, the editor-in-chief sends a friendly message to collect more information. While the article represents the reporter's final assessment of the causes of the riot, comments in the notebook are helpful in understanding a student's thinking and initial reactions to the subject matter.

Relating Material to the Present

After completing the article, the student is brought back to 1990s and asked to discuss with other students what he or she has learned in relation to current events. They are asked to consider recent events such as the boycott of Korean food stores in Brooklyn in 1991 and the Los Angeles riots of 1992. These are excellent topics for group discussions and provide opportunities for students to express their views as well as to hear the views of their fellow students on sensitive topics such as race, religion, poverty, and ethnicity. The objective is for students to begin to understand group conflict as a recurring historical theme which has permeated the American urban experience.

Evaluation

The evaluation of instructional software lends itself to a methodology that relies on dissemination and feedback as the software is developed. In this project, as the software was being developed portions were viewed and feedback solicited. Based on the feedback, modifications were made. The advantages of this developmental evaluation model over a traditional experimental model is that it is conducive to the development of quality instructional software (Willis, 1991; Dick and Carey, 1985; Thiagaran, Semmel, and Semmel, 1974).

During the development of the program progress demonstrations were made locally with representatives from IBM, the CUNY Office of Academic Computing, faculty from other CUNY institutions, Bank Street College, Columbia University, and New York University. Observing students using the program also provided valuable feedback. In general, students liked using it very much. As education majors, they especially appreciated seeing another format for delivering instruction. In one discussion with students, while they were positive about the program, the consensus was that multimedia should be used in conjunction with other teaching activities and should not be the sole method of delivering instruction. At the time of this writing a follow-up grant proposal was being reviewed. The intent of the proposal is to conduct more extensive evaluation at LaGuardia Community College in New York City. Faculty at LaGuardia Community College have been using the original videotape program in several of their introductory social science courses.

Conclusion

In this article the primary emphasis was placed on the conceptual and pedagogical design of a multimedia program. While motion, color, and music can stimulate interest design techniques that arouse curiosity, involve students, and build a desire to learn have been found to be more important. In the long run, these techniques are universal to all teaching and learning and will surely outlast the hardware and software.

A second goal of this paper was to demonstrate that educational foundations, methodology, and technology can be integrated. While either one separately is important, their integration provides a very effective instructional example for future teachers.

Lastly, the designers of "The Five Points..." consider the finished product a good model for similar multimedia projects, especially those dealing with social science subject matter. Designing and developing the program has proven to be a worthwhile and stimulating exercise. Such a project is highly recommended for the challenge it provides faculty in working with new technology and perhaps, more importantly, for exploring different pedagogical approaches.

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Developing a multimedia social studies lesson

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The information explosion of the last decade has had a dramatic impact on library holdings, on elementary and secondary textbooks, and on curriculum decision makers at all instructional levels. Libraries are struggling to update and increase their holdings as printed materials are increasing at a geometric rate. Networking, laser disc, fax machines, and interactive technology are being used to meet the challenges of the decade and of the 21st Century. Textbooks used in elementary and secondary schools are being revised and rewritten in response to criticism of educators and the media as answers to educational problems are sought. Teachers, school administrators, and the tax paying public are questioning whether the curriculum and instructional materials which are in use in elementary and secondary schools really meet the challenges of post-industrial age.

Tyson-Bernstein (1988) and Woodward (1987) cited several reasons why student textbooks are limited in value. Among them are: 1) attempting to cover too many topics resulting in each being covered superficially, 2) over condensing of subject matter, 3) a style of writing that is uninteresting and fails to provide a meaningful context for the information presented, 4) presenting limited information about minorities and women, and 5) including pictures and graphics which are either unrelated to the text or have so little explanation that they add little or nothing to the reader's understanding of the text.

Britton, Van Dusen, Gulgoz, and Glynn (1989) and Duffy, Higgins, and Mehlenbacher (1989) found that texts in which the writer emphasized coherence and structure and identified key ideas seemed to insure more learning and student enjoyment. Organization and content representation are significant factors in updating both methods of teaching and textbooks used in social studies.

Assuming that state of the art technology used with textbooks and curriculum mandates will increase interest, give another mode of learning the content, and provide another way teachers can address individual differences, studies of computer use by social studies teachers were reviewed. Ehman and Glenn (1987) reported that computers were little used by social studies teachers at that time. They cited the lack of training, limited availability of software, and lack of computers in social studies classrooms as the reasons. In a later study of social studies teachers, Goodspeed (1988) found that although the respondents believed that computers have value when used in the classroom they felt that training in the use of computers and technology in the classroom was a necessity if use were to increase. Not only do teachers need to become comfortable with computers as teaching tools but they also need to recognize the powerful influence that interactive multimedia can have on teaching and learning. As Falk and Carlson (1991) note,

> *interactive multimedia provides a powerful new educational tool that can greatly enhance teaching and learning. Research and experience indicates that use of multimedia leads to enhanced learning on criteria such as acquisition of content, development of skills, efficiency of learning and satisfaction with instruction (p. 12).*

Falk and Carlson also report that, to date, very few schools are using interactive media approaches in instruction and that teachers must learn how to use instructional technology effectively.

Faculty of the College of Education of the University of Southwestern Louisiana have been working on a model which can be used to help elementary and secondary teachers use interactive video and multimedia. The model is an interactive video enhancement model which can be used with state and district approved grade level textbooks. In addition, since many school systems only provide a limited number of computers per classroom, or limited access to computers, teaching teachers how to use an interactive media projection station for whole class instruction was thought to be the most valuable skill to work on.

Planning was done in several stages. First, elementary social studies textbooks were reviewed to select possible demonstration units that could be used in preservice and graduate level methods classes. After several topics were selected a study of video laser discs was made to determine availability; local library holdings were surveyed to determine the availability of related children's books; and, collections of video tapes and films were reviewed. Specific topics, for which relevant additional materials were available, were then identified. Because the model being developed was intended to help teachers move from their familiar teaching mode into one where interactive technology would be equal to, or greater than, the use of a text our next step centered around building a graphic organizer which would identify the major concepts presented in the text. Following this, the selected video laser disc was viewed to identify major concepts presented and to identify those which would enhance the student textbook presentation through elaboration and/or introduction of additional concepts. Frames from the laser disc were selected and the numbers of the frames added to the graphic organizer of the social studies text. As the graphic organizer of the student textbook and the video laser disc were examined attention was directed to additional areas which needed to be expanded, explained, or studied by the elementary student. Appropriate video tapes were viewed to see how they could be used in the video-enhanced teacher-directed instructional lesson. The electronic encyclopedia was checked to supplement concepts included in the text but not apparent on the laser disc and/or the video tape. We found that cultural aspects of the topic—including art, music, dance, and sports—were covered in detail in the encyclopedia. In addition, children's books were selected which could be used to enrich the topic and encourage independent reading.

After the selection of material was completed a HyperCard stack was developed. It was structured to accesses the various frames of the video tapes and video laser disc which correlated with the categories and/or concepts to be emphasized in the unit of work. The stack included objectives for the lesson and student assignments. Some objectives were those suggested in the teacher's manual and others were based on the selected multimedia technology. Questions designed to elicit higher order thinking skills were also included. Suggested enrichment activities completed the stack.

The HyperCard stack using multimedia technology to supplement the student textbook is primarily designed to help teachers use multimedia projection stations during teacher directed lessons. However, HyperCard stacks, with minimum adjustment, can also be used for independent and small group work including exploration, comparative studies, and individualized problem solving. This is particularly true if the classroom is equipped with individual learning multimedia projection stations with smaller monitors.

A full paper including a completed lesson plan from a unit on Japan is available from the authors. A sample of the HyperCard stack for use with the Japan unit will also be copied if a disk is provided.

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The role of technology in education in the NEW South Africa

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The Republic of South Africa is undergoing a radical upheaval in the structure of its social and educational systems. Although apartheid has been "abolished" at the official level, and a NEW South Africa declared, it is as yet undefined and many aspects of apartheid remain de facto. In essence, NEW South Africa means "life after Apartheid." But there are many definitions of what that should be and there is absolutely no clarity about the details of how a unified society and education system will look. It would appear that the present government, in anticipation of losing power, would like to decentralize power and privatize industry; whereas the African National Congress and other non-white political organizations, in anticipation of taking power after having been on the receiving end of a strong centralized government, are leaning towards strong central control with themselves as the leaders.

In light of this unsettled situation, examining the educational system and the use of technology provides some tremendous opportunities for effecting positive change. The fact that change will occur is clear; what remains unclear is the kind of change that will occur. This paper will 1) describe the current state of education and the use of technology in South Africa, 2) explore benefits of technology and computer education and the possibilities for its future use in South Africa, and 3) delineate some of the barriers that must be overcome if technology is to be integrated effectively into the South African educational environment.

Current State of Education

As one looks at the present situation it is important to keep it mind the population distribution of the nation: 75% black, 9% colored (people of mixed race), 3% Asian (mostly Indian, not including Japanese and Chinese who are classified as white under apartheid laws), and 13% white. This breakdown represents the racial classifications that existed under apartheid and is important when examining the school systems because each classification had/has a separate education authority in the major governing regions. The Republic of South Africa has 27 education authorities that control the education in its governing divisions of provinces(four), homelands (four), and self-governing regions (six). Each division can, therefore, then have up to four separate education authorities to deal with each of the racial classifications in its authority. Each authority, however, has some autonomy.

The curriculum for the four homelands and six self-governing regions is set by the Department of Education and Training, which is a federal office. The four provinces set their own curriculum. The curricula are used to develop the exams given at the end of the school experience. These are called matriculation exams and they must be passed to receive a secondary school diploma.

In 1986 the South African Certification Council was founded in an effort to control the standards of subject matter and examination as well as the awarding of certificates at the various exit points in schools, technical colleges, and non-formal education. The major objective of the council is to insure that all certificates awarded by the different examining bodies at specific exit points are at the same standard (Strauss, Plekker, and Strauss, 1991).

There is a great deal of inequity in funding of public education. National funding levels per student in South Africa for each of the racial classifications are: Black - R930 (~ $310), Colored - R1983 (~$661), Asian - R2659 (~$886), and White - R3739 (~$1246) (KwaZulu Training Trust, 1991). This funding is used to pay for basic textbooks, testing supplies, teacher and administrator salaries, and one-half the cost of the school building. The individual school communities must raise funds for all other needs such as phone, secretaries, general supplies, non-text materials, and any extra teachers needed above the basic number allocated by the government. These funds are raised voluntarily from the people served by the school in such forms as tuition, donations, and corporate sponsorship.

In South Africa there are 20 universities with schools of education, which, since the renunciation of apartheid laws, are "open to all races" although most are still, in effect, segregated. These schools of education provide what we would consider an equivalent to a Bachelor of Education. In addition to the university-level training of teachers there are 94 teacher-training colleges in South Africa. These are found in all areas of the country and service all four racial classifications. The majority of them are, however, traditionally black institutions. These schools provide a three-year course of study aimed solely at providing teaching certificates, much like the old normal schools did in the United States. The difference between the two degrees appears to be that the bachelors degree focuses on a thorough academic understanding but lacks pedagogical preparation, whereas, the teacher training institutes focus on how to teach but not on extensive mastery of what will be taught.

South Africa has four official languages — English, Afrikaans, Zulu, and Bantu. Each child is instructed in his or her mother tongue through the first two years of schooling. At that point the language of instruction is either English or Afrikaans. For the native English or Afrikaans speaker there is no switch; the child whose mother tongue is different, however, must change. The problem is that English is spoken only in formal instruction, while most informal language usage, both in and out of school, remains in the student's mother tongue. In classroom settings the large majority of students do not receive instruction in their first language.

This situation contributes to the following statistical description of the state of education in South Africa.

Table 1
South African Educational Statistics

	Black	Colored	Asian	White
% of Population	75%	9%	3%	13%
Literacy rate	22%	45%	77%	98%
Matriculation rate	6%	7.5%	21.5%	42%
Student:Teacher	41:1	23:1	20:1	18:1
Student:Classroom	48:1	24:1	28:1	18:1

Source: KwaZulu Training Trust, University of Zululand.

Table 1 shows that the majority of the population (black) has a secondary school matriculation rate of 6%, a literacy rate of 22%, an average classroom size of 48.2 students, and overall student/teacher ratio of 40.6/1. The minority white population has a secondary school matriculation rate of 42%, a literacy rate of 98%, an average classroom size of 17.8 students, and an overall student/teacher ratio of 17.8/1.

When looking at matriculation figures it should be noted that in the South African system matriculation means finishing the last year of secondary school (Standard 10) and passing a comprehensive written exam. The exam is used to screen candidates for future education but is not necessary as a job requirement.

To an educator visiting the black schools in KwaZulu (the Zulu self-governing territory in northern Natal) the lack of instructional materials is evident. There are no school libraries and few print materials visible in the classroom (even English classes). Students do not have paper, pencils, books, or other materials. One principal stated that even though the Department of Education provides textbooks the principal is personally and financially responsible for them. If any are lost or destroyed during the five-year life of the textbook the replacement cost comes from the principal's salary. In the society at large there are not the number of magazines, newspapers, and public libraries that we take for granted here in the United States. Those available are extremely expensive in relation to the salaries of the general population. The cost of books, in conjunction with the lack of public libraries, does not encourage casual reading within the population. The lack of equipment in some black schools is equally severe. For example, a professor at the University of Zululand in charge of student teachers stated that a chemistry teacher in a rural school had never seen a test tube. Those schools that do have equipment and supplies are sponsored by major corporations, are usually located near the corporate worker's living facilities, and cater to future workers of the corporation. This situation creates schools that are very inequitable within the same community.

The availability of technology in the schools parallels the social structure found in the country. The traditional white schools are relatively well supplied with current technology. It is not always used well, particularly computers, but it is available. On the other hand, the great majority of black schools lack all forms of technology. This is due, in part, to the lack of electricity in over half of the black schools in the country. What instructional technology that can be found in the black schools is a direct result of either corporate or university involvement with the school. IBM has established over 100 Writing to Read programs at the primary levels in an effort to provide English instruction and computer literacy experiences. However, once the children leave the program no further computer experiences are available. A number of universities (e.g., University of Zululand, University of the Western Cape, and Rhodes University) have established outreach programs to secondary schools in their areas. These projects usually involve providing supplemental instruction to students in mathematics, science, and English. The majority of these programs use PLATO as their program base, although a number of institutions are moving away from PLATO to other systems that allow authoring of lessons customized to fit local needs.

Benefits of Technology

Hawkridge (1990) presents a classification of rationales for using Information Technologies that are particularly relevant to the present situation in South Africa. Each will now be discussed.

The Pedagogic Rationale puts forth the belief that computers can teach — that there are elements of the learning process that can be achieved, partly or completely, by interaction with a computer. For example, a major problem that computers may be able to address in South Africa is the poor preparation of many (particularly rural) teachers. Computers can be used to provide supplementary resources to the teacher in the form of expert lessons and time-saving administrative aids.

Teachers in South Africa are presently trained to run teacher-focused classrooms as providers of information and education. The high student/teacher ratio restricts the quality of education that it is possible to provide. There are a number of ways in which using computers can help. First, computers can take over drill and practice instruction, class management, and class testing. In doing so, students are provided with immediate feedback and a kind of neutral response (the program cannot be culture-free, but at least the computer doesn't judge who presses the button, only which button has been pressed). Second, computers can help meet the needs of the individual student, helping the teacher to better accommodate mixed-ability classes. Third, the learning time/timetable does not depend on the availability of the teacher. In fact, the computer could be available 24 hours a day.

Another way in which a technology, such as computers, can be particularly helpful to under-prepared teachers is in the area of content knowledge. The use of computers and well designed software allows the teacher to be a facilitator of learning rather than the reservoir of knowledge. Facts and information can come from the technology, giving the teachers access to another "presenter of the facts" and freeing the teacher from the necessity and pressure of having to know everything. In turn, the teachers' dignity is preserved and they "save face" in a culture that places a high value on these attributes.

The effectiveness of computers in improving academic results is particularly important in a country in which test scores determine a student's future education. There have been a number of studies (Samson, Niemiec et al., 1986; Kulik & Kulik, 1986; Bangert-Drowns, Kulik, & Kulik, 1985) that show improvements in measurable factors — particularly for disadvantaged students. This secures the place of the computer as a provider of drill and practice, as a means of exploration (e.g., problem solving and simulations), and as an information processing tool.

The Vocational Rationale emphasizes learning applications and programming. This rationale is common among developing countries where unemployment and poverty create an awareness of a need for useful skills in the workplace. In a sense, there is an economic imperative for Information Technology in education: a skilled work force will be able to generate more (communal) wealth than an unskilled work force.

The Special Needs and Cost-effectiveness Rationales both deal with providing effective instruction in specific situations. The advocates of these rationales would say that there is such a crisis in education in South Africa that there is no hope of a solution without technology — the only way to tackle the problem of the limited funds at the country's disposal is to use technology. Such things as CD-ROM, video tape/video disc, and telecommunications are a less costly means to the mass distribution of information than the production, distribution, and housing of equivalent print materials would be.

The Catalytic Rationale states that computers can foster desired change in education. Although this potential is not inherent in the medium but depends on the use to which Informational Technology is put, the computer can be used as a tool to encourage problem solving and meaningful learning. This would mean a fundamental shift from much of the rote-learning/exam-focused teaching that takes place in South Africa today. This rationale is particularly pertinent today in that the country is going through a time of great expectations with regard to change, especially educational change. Much of the revolution in South Africa since 1976 has been driven by youth who expect radical and innovative change leading to a modern and relevant education system. In this regard, it is important to note the possibilities of the computer as an empowering mechanism. For example, teachers who are able to use technology effectively can produce locally relevant materials that are up-to-date and that can be easily shared. It would decrease their reliance on (government-sponsored) textbooks.

The Social Rationale sees computer awareness and literacy as part of general preparation for modern life. However, a social rationale must be community driven for a community harnesses the power of the technology to achieve ends which it identifies as useful. The white population of South Africa with its higher level of education seems to reflect this awareness. The larger black community fears computers as threatening their employment opportunities. Their concerns are focused on day to day existence rather than reflecting the awareness of the necessity of a computer literate population if they are ever to become a first world country.

The Information Technology Industry Rationale states that some systems have been promoted by commercial interests rather than educational ones. That is not a criticism in itself. Indeed, commerce and education ought to work together, but the emphasis should be on education rather than profit. In the black schools in South Africa where Information Technology is found it is a direct result of corporate sponsorship. The need to make this type of technology available to all schools, regardless of their direct relationship to a specific corporate interest, is paramount.

Barriers to Overcome

As we examine barriers to using technology as an instrument of education in South Africa we find many of the same barriers found in the United States. The problem is more pronounced in South Africa because the majority of students are in the black education system. Many of these barriers, alluded to in the benefits section of this paper, are due to the poverty of the educational system, the authoritarian manner of the traditional teaching model, and the basic human condition of the black majority.

Abraham Maslow (1954) states that before a person can concentrate on education (the need to know and ability to understand the pleasure in learning) he or she must be provided with basic human needs such as food, warmth, safety and security, the feeling of belonging in social and personal relationships, and self-esteem. These are human needs denied by apartheid. They account for the majority of the concerns expressed by the students in South Africa today.

Athol Fugard (1989), in his play "My Children! My Africa!," which deals with the social and educational struggle in South Africa, comments through a young black student about a school boycott called by a political group:

> *The comrades are imposing a discipline which our struggle needs at this point. There is no comparison between that and the total denial of our Freedom by the white government. They have been forcing on us an inferior education in order to keep us permanently suppressed. When our struggle is successful there will be no more need for the discipline the comrades are demanding.*

Many black South Africans feel that the "inferior education" imposed by the white government is a result of the authoritarian nature of the government and the political system. The education system they control has been designed to teach compliance rather than independence. It has stifled initiative and motivation leading to a profound sense of personal disempowerment. The truth is, in fact, that the black population has little power not only in many of the decisions taken about them through the colonial structures but also through the traditional tribal structures. This leads to a relinquishment of responsibility for their own lives, including their education, and causes pupils to often take initiatives.in misguided and destructive ways, such as burning classrooms and killing teachers (as in Fugard's play). While the students have the power, they lack the knowledge and experience to direct themselves in productive ways. School boycotts go on, disrupting school for hours, days, or weeks. While school is in session, the time students should be devoting to academic tasks is used to plan future political actions.

Money provides another barrier to education. Such things as rural electrification, availability of educational resources and supplies, adequate numbers of adequately trained teachers, the production of good and relevant courseware, and sufficient equipment all could be put in place now if the funds were available.

A final barrier that must be overcome is one of attitude. Attitudes that represent a major barrier to the incorporation of technology in the educational system and work force are that: 1) the use of technology steals jobs from people, 2) teachers and lecturers feel that they will no longer be the dispenser of knowledge, and 3) the belief that software programmers and lesson designers impose their own biases (e.g., cultural) on the instructional material.

Conclusions

There are a vast number of needs competing for priority in South Africa. This is unlikely to improve in the short-term. The attempt to redress decades of inequality will involve massive input and time. However, both the South African economy and the education system are in a state of crisis. There is a high unemployment rate, a pressing need for poverty relief, and little money for education. At the same time there are vast numbers of children of school age—48% of the population are under the age 19 (South African Institute of Race Relations, 1992). The recognition of a need to address past inequalities places huge demands on available resources. This means that schools will increasingly have to rely on the communities they serve and on industry/commerce partnerships for resources. Considering the current state of schools in many areas, particularly rural areas, a large portion of the funds available will be spent on critical areas like salaries and buildings.

There are, however, extremely good reasons for investing in Information Technology. There is, as well, a significant voice in the South Africa educational system that believes not only in the potential but in the necessity of Information Technology in education. Although computers are the medium usually associated with Information Technology other media such as television, radio, and videos, have educational potential as well. A question that needs to be answered is "Will Information Technology contribute to the educational aspirations of the people in a positive way?" We believe the answer is yes, and that Information Technology should — and will — receive significant attention from educational authorities in the NEW South Africa.

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INSERVICE & GRADUATE EDUCATION

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Overview

The focus for this year's section on graduate and inservice programs in technology and teacher education appears to address the question, "What steps can be taken to ensure effective instruction of teachers?" The authors in this section propose solutions to the problems of delivering instruction that transfers the the classroom so that teachers make use of available technology, use the technology appropriately, and maintain the innovative practice after the training ends.

The authors of articles in this section propose a wide variety of models for inservice, analyses of preconditions, and programs focussed on innovative uses of emerging technologies. Some of the models have proven effective for other types of training or education, and are translated to the technology and teacher education. These typically have a solid research base and fine tuning that has occurred over several years. Other models are emerging as unique to the field. This collection of articles constitutes an important research base that will guide readers through a broad choice of approaches to the design of inservice activities and graduate programs. Many of the studies merit replication, particularly since they encompass a range of assessment activities that can and should be applied so that further research can continue to help practitioners refine their offerings.

Models of Effective Instruction in Technology and Teacher Education

Copley and Williams worked with middle school mathematics teachers to determine the effects of coaching on the use of calculator technology in the classroom. They utilized a modified version of the Joyce and Showers (1988) coaching model, and compared coached and non-coached teachers over four constructs: higher-level content, use of calculators as a problem-solving tool, student-initiated use of calculators, and teacher-initiated use of calculators. The positive results of coaching teachers provide strong evidence that this model can be effective in many areas of technology use in the classroom, particularly since the innovation is highly complex and is too often abandoned without continued support.

Grandgenett and Mortenson propose a model called TEAM (Technology in Education Advancement model) in which education and technology specialists and institutions collaborate to plan, deliver, and follow up on instruction in technology use, utilizing an eight-phase approach. Although no data have been gathered to measure the effectiveness of the model, the authors clearly feel that the collaborative behaviors they have observed in TEAM participants represents success in meeting project goals.

Bahr, Kenney, and Hannaford employed a training model that compared implementation effects among three groups of teachers receiving training specifically aimed at technology integration, traditional training (software demonstration and hands-on practice), and no training. A precondition for the training included the evaluation of over 100 software packages so that appropriate materials would be preselected, given that teachers have little time for this activity. Although final results are not yet in, the authors have evidence that teachers do not make use of customization and record keeping options when these features are available from software packages.

Smith and Smith propose a model of inservice training that explicitly defines three areas of need: skills, integration, and mentorship. They list the potential benefits of this design to the participants, the school district, and the university. Williams and her colleagues suggest participation in curriculum development as a key factor in teacher implementation and student achievement. Among their interesting findings is that this type of participation is a better predictor of quality of implementation and teacher selection of student activities than is attitude towards the technology.

Other factors have impact on the effectiveness of the highly complex activity that is teacher training in technology use. Luna and Foster utilize a technology lab situated at the university to establish a precondition for implementation: that teachers have access to training and resources, particularly when isolated in rural areas. Casey applies the research on effective leadership to establish another important precondition to effective implementation of technology: the school principal is a key player who should possess the knowledge and skills for appropriate use of technology.

Schneiderman's paper describes an educational community on Long Island whose energy is harnessed to build a shared vision of educational computing and the "creation of a learning organization." They explicitly teach networking skills so that the sense of community is highlighted and maintained. Roberts and Ferris address the fundamental problem of faculty expertise within teacher training institutions and describe important issues related to the lack of progress in infusing technology into higher education classrooms.

Todd's article focuses on the training of school media specialists in a role of leadership and support for educational technology use in the classroom. She proposes the use of an adapted concerns-based adoption model and describes how this might work for the media specialist training.

Innovative Applications

Four of the authors in this section propose instructional events that are based on cutting edge technology. Parker describes facilities and the resources within those facilities that he feels are essential to integration of technology. Tellez and Miller describe how bar code technology can be applied to record keeping and thus reduce the clerical overhead that occupies teacher time. Baumbach, Bird, and Brewer describe facilities and procedures for launching videodisc technology use. Kolvoord utilizes a constructivist approach in the use of image processing to facilitate children's exploration and discovery in various topic areas.

Future Directions

Clearly, the trend in inservice and graduate education is the empowerment of teachers. Models that suggest collaboration, participation in planning, community structures, facilities that support teacher efforts, and a focus on teacher concerns are moving towards the decision support that has proven effective in the corporate milieu. Breaking down the isolation of the classroom teacher and other key players in the educational technology arena is a theme of these papers and the evidence that supports this aspect of school restructuring is only beginning to appear. I can only urge that studies of the effects of these practices continue to emerge and be replicated, and that assessment models be proposed so that each of us is not faced with the reinvention of the wheel.

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The effect of coaching of the use of technology in middle school mathematics classrooms

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Theoretical Framework and Objectives

The importance of teachers observing other teachers, the participatory role of the teacher in the creation of curricular innovations, and the development of peer and self-reflective strategies have been advocated since the mid-seventies and continue to be a focus of studies (Berman & McLaughlin, 1975; Fullen & Pomfret, 1977; Sharan & Hertz-Lazarowitz, 1982; Showers, 1984; Williams, 1992). Coaching, a process in which teachers can interact with other teachers to practice new and experimental techniques without fear of evaluation, is the method that is often implemented to accomplish effective change (Joyce & Showers, 1988). Coaching appears to contribute to transfer of training by encouraging greater long-term retention of knowledge about and skill with strategies (Baker & Showers, 1984) along with a more appropriate use of newly learned strategies and models of teaching (Showers, 1982; 1984).

The use of technology has long been advocated in mathematics classrooms (National Council of Teachers of Mathematics, 1974; 1989). The Mathematical Association of America (1991) stressed the need for changes in mathematics curriculum at all levels and added its support of calculator use by claiming that students can more rapidly apply a mathematics understanding in problem-solving situations when students regularly use calculators. However, recent studies have shown that even though the use of technology has increased in middle school mathematics classrooms, technology has not been appropriately implemented and integrated into instruction and curriculum (Copley & Williams, 1991; Williams, 1992).

The purpose of this study is to investigate the effects of coaching on the use of technology in the mathematics teachers in middle school classrooms. Specifically, do teaching behaviors of teachers involved in a coaching program differ significantly from identified teaching behaviors of teachers who are not involved in a coaching program? Three general issues are addressed: (a) the higher-level content focus in lessons using technology, (b) the use of technology as a problem-solving tool, and (c) the use of technology especially focusing on who initiates its use. Because of the current emphasis on the use of technology and more specifically, calculator use (National Council of Teachers of Mathematics, 1991), the identified teaching behaviors were all linked directly to instruction using a calculator.

Methods

Fourteen middle school teachers from a large urban school district in the southwest registered for a masters-level education class entitled, "Problem-Solving with Calculators". The content of the course included a) instruction on the use of calculator technology, b) modeling sessions by class participants of the content emphasized during instruction, c) four or more individual coaching sessions with university faculty, class participants, and peers as partners and d) an introduction to a variety of activities involving higher-level content and technology. The class instruction focused on how the calculator could be best used as a tool for higher-level thinking, problem-solving, and student involvement. The importance of a student-centered classroom with its implications were stressed and modeled during the problem-solving class as well as during the coaching sessions.

A modified version of Joyce and Showers (1988) coaching model was used during class instruction as well as during the individual coaching sessions. All coached teachers participated in the four individual coaching sessions. The sessions followed the following sequence: (1) university faculty - teacher, class participant - coach, (2) class participant - teacher, university faculty - coach, and (3) class participants - peer coaching, and (4) class participants - peer coaching. Each coaching session began with a presession in which the teacher and coach discussed the upcoming lesson objectives. During the coaching session, the lesson was taught by the teacher and the coach recorded observations, questioned students about their understanding of the lesson, and noted specific concerns. The coaching session then ended with a post discussion between the coach and the teacher in which the concerns were addressed, the observations and recommendations reported, and future plans made.

Fourteen additional middle school teachers from the same school district were randomly selected to represent the non-coached group. Since the teachers taking the class were self-selected and impossible to randomly select, the non-coached and coached groups were compared using demographic data. Both groups were similar in educational background; seven of the coached teachers and six of the non-coached teachers had a master's degree. Twelve of the non-coached teachers and eleven of the coached teachers had taken classes after their degrees had been awarded. In addition, both groups had approximately the same number of years of experience. The coached group's average was in the 10 to 14 years range while the non-coached group's average was in the 5 to 9 year range. The only observable difference between the experimental and control groups was in the level of their certification. Nine of the fourteen coached teachers and four of the fourteen non-coached teachers were elementary-certified rather than secondary-certified.

Behavioral indicators of four constructs were written to measure the use of calculator technology in the classrooms of the 28 middle school teachers. The constructs matched as closely as possible the objectives of the coaching sessions and the instruction during the problem-solving class. Construct 1, "higher-level content focus in lesson" contained five behavioral indicators. The indicators were (a) lesson content focuses on application skills, (b) lesson content focuses on analysis and synthesis skills, (c) lesson content focuses on evaluation skills, (d) lesson content poses problems, and (e) lesson content requires problem solving. Construct 2, "use of calculators as a problem-solving tool" contained five behavioral indicators. They included (a) teacher allows students to determine appropriate use of calculator, (b) teacher emphasizes importance of estimation to determine reasonableness of calculator answer, and (c) teacher stresses use of calculator as a problem-solving tool. Both construct 3, "student-initiated use of calculator" and construct 4, "teacher-initiated use of calculator" were measured using only one behavioral indicator apiece. The behavioral indicators were contained within the *Observation Rating Scale for Calculator Implementation* (Williams, Waxman, & Copley, 1990).

All teachers were observed by trained observers at four separate times during a 45 minute mathematics class period. Two of the observations occurred during the fall in which the coaching sessions and the problem-solving class took place (DurCoach). The other two observations took place during the following January after the class had finished in December (AftCoach). Teachers were unaware that they would be observed during the randomly-selected period; coaching sessions were never observed by the trained observers. Observers rated each item on the instrument using a 5 -point scale to indicate the amount of time each behavior occurred. A high score for an item or indicator revealed that teachers were frequently observed using the particular behaviors. The inter-rater reliability was greater than .90.

Analysis of Data and Results

Mean scores on the indicators were calculated for the observations conducted during the class and coaching sessions (DurCoach) as well as for the observations conducted immediately after the class (AftCoach). T-tests were used to determine if there were significant differences ($p<.05$) between the coached and the non-coached groups on each of the four constructs during coaching (DurCoach) and after coaching (AftCoach).

Significant differences were found for three of the four constructs (Table 1). The coached group spent significantly more time focusing on higher-level content than did the non-coached group during the coaching period and after the coaching period ($t=2.26$, $p<.05$ for DurCoach; $t=2.21$, $p<.05$ for AftCoach). Significant differences during the coaching period were found between the experimental and control groups for both "use of calculators as a problem-solving tool" ($t=2.29$, $p<.05$) and "student-initiated use of calculator" ($t=2.95$, $p<.01$). On both constructs, the coached group had higher means. No differences were found between the coached and non-coached group on the construct, "teacher-initiated use of calculator" during or after the coaching period. The means for three of the four constructs increased after the coaching period for both the coached and non-coached groups.

Educational Importance

The implementation of curricular or instructional innovations involving technology is essential to the nature of education. Instruction of inservice and preservice teachers often focuses on methods to encourage the implementation of those innovations. The results of this study confirm previous research regarding the effectiveness of coaching and add to the research base the observable effects of a short-term coaching model on the appropriate use of technology. The significantly greater higher-level content focus of the coached group of teachers that occurred during the coaching session and persisted even after the coaching session is a promising finding. While the concentration on higher-level content was not high for either the coached or non-coached teachers, the fact that the coached teachers who were introduced to higher-level activities implemented them in their classroom more than the non-coached teachers suggest that coaching has benefit to both instructional and curricular issues. The significantly higher use of calculator technology as a problem-solving tool by the coached teachers during the coaching session seems to be in conjunction with the higher-level content focus and further supports the effectiveness of coaching.

The significantly greater student-initiated use of calculator technology by the coached teachers along with their almost identical teacher-initiated use of calculator technology when compared to the non-coached group, suggest that the coached teachers began to be more student-centered. In addition, it may indicate an increased comfort level with calculator technology by the teachers involved in the coaching session.

Acknowledgements

Support for this research was provided in part by a

Table 1
Results of T-Test Analyses between Experimental Group (Coached) and Control Group (Non-Coached) on Observations of Three Constructs

CONSTRUCTS(possible range)	DurCoach				AftCoach		
	M	SD	t-test		M	SD	t-test
1: Higher-Level Content Focus in Lesson (5-25)							
Experimental	6.57	1.31			7.54	1.46	
Control	5.61	.90	2.26 *		6.43	1.17	2.21*
2: Use of Calculators as a Problem-Solving Tool (5-25)							
Experimental	7.89	2.82			8.29	3.78	
Control	4.89	4.01	2.29*		7.14	4.12	.77
3: Student-Initiated Use of Calculator (1-5)							
Experimental	2.68	.80			3.14	1.12	
Control	1.79	.80	2.95**	3.14	1.08	.00	
4: Teacher-Initiated Use of Calculator (1-5)							
Experimental	1.89	.94			1.54	.87	
Control	1.86	.97	.10		1.21	.38	1.27

* $p < .05$
**$p < .01$

grant from the U.S. Department of Education, Dwight D. Eisenhower Mathematics and Science Education Program (Grant No. R168DOO311). Opinions and views expressed in this paper are those of the authors and do not necessarily reflect the positions of any government agency.

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A collaborative inservice model for training teachers in advanced technologies

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Introduction

Over the last decade, increasingly powerful computers and related educational technologies have emerged for use in the design and delivery of classroom instruction. The pace of technical change during the last ten years is indeed impressive, and teachers have watched classroom technologies quickly advance from simple drill and practice programs written in BASIC to impressive multimedia packages using CD-ROM and video laser disks. Yet such a rapid technical advance is producing a challenge to teacher training efforts, as classroom technologies are changing almost as fast as teachers can be trained in them (Retterer & Raker, 1990; Irwin, 1990; Jongejan, 1990).

The rapid emergence of new products is making it difficult for school district and university technology specialists to keep up, and many of these resident experts are becoming aware that they will no longer be able to be knowledgeable and to teach all types and aspects of technology to their teachers. In essence, they are finding a need to collaborate in the technology training of teachers, by relying on others for particular topics and aspects of inservice programs. There is also a recognition that training in technology will never truly be "completed" and teachers will need to be periodically brought up to date in new advances as they become available for classroom instruction.

Thus, along with new technologies, a new approach is also emerging related to teacher inservice in educational technology. This approach involves extensive collaboration between education and technology specialists, and institutions, to help meet the changing needs of teacher inservice (Phillips, 1986). This paper describes a specific model for this new collaborative approach to training teachers in educational technology, called TEAM (Technology in Education Advancement Model), which has been used successfully for a completed project and an ongoing project within the Omaha, Nebraska area.

A Collaborative Environment

In the metropolitan Omaha area, the College of Education at the University of Nebraska at Omaha (UNO) and the seven urban school districts have banded together to share resources, ideas, concerns, and effective practices. This cooperative approach between and among the seven urban school districts and College of Education is fairly unique in the United States. The result has been the formal establishment of the Metropolitan Omaha Educational Consortium (MOEC). The consortium members share a common purpose: to provide the best education possible for the metropolitan Omaha area, which will be achieved, in part, through the utilization of present and emerging technologies.

MOEC has identified five major task forces centering on the themes of: Educational Technology, Staff Development, Early Childhood Education, Health Education, and Middle School Education. The scope of the combined school districts in the Metropolitan Omaha Educational Consortium encompasses 82,600 students and 4,500 teachers within 155 schools.

The existing structure of MOEC has provided an environment for the design and delivery of cooperative inservice teacher education projects which have followed the inservice model described in this paper. The Dartmouth-Nebraska Partnership project, which was the first Omaha Project TEAM, emerged from this MOEC collaborative environment. This initial Project TEAM was financed through a partnership with Dartmouth University and the University of Nebraska at Omaha where an inservice teacher education program in emerging educational technologies was designed and delivered in the metropolitan Omaha area. Teachers from the local school districts teamed with professors from the university to design curriculum packages that integrated educational technology for delivery in classrooms. Both the teachers and professors prepared curriculum materials from their respective classrooms as well as being active learners in the same workshop.

From this first project emerged a second TEAM project entitled Project TEAM—Secondary Mathematics, which began in August of 1992, and is currently ongoing. Project TEAM—Secondary Mathematics was funded by the Helena Foundation and is specifically designed to provide inservice teacher education for secondary school mathematics teachers. The inservice program focuses upon integrating advanced educational technologies into the traditional secondary mathematics curriculum.

The Technology in Education Advancement Model (TEAM)

Effective teacher inservice has been identified by numerous researchers as a prerequisite to the effective integration of educational technology into the schools (Friedman, 1991; Wood & Smellie, 1990). Merely supplying teachers with technology often does little good unless the teachers are also carefully trained to use the technology through an appropriate inservice program. However, teacher inservices need to be well planned and delivered to be successful (Boe, 1989; Hoffman, 1988). A few hastily offered after-school training sessions are usually not enough to encourage the active integration of technology into instruction. Instead, inservice programs need to be systematically planned and structured. Most importantly, inservice programs need to concentrate on gradually changing teachers from technology learners to technology users, and be structured to emphasize and assist ongoing curricular goals (Hubbard, 1989; Hoffman, 1988; Moursund, 1984). The technology inservice model described in this paper (TEAM) represents such a careful and systematic approach; that has been successfully implemented within the Omaha area.

The model for collaborative inservice training in educational technologies represented by TEAM is divided into 8 distinct phases: 1) partnership planning, 2) program design, 3) participant selection, 4) awareness instruction, 5) experience instruction, 6) classroom integration, 7) project closure, and 8) dissemination. For the institutions involved, the multiphased approach recognizes that collaboration takes careful planning and time. Thus, phases 1, 2, and 3 are dedicated to the need to build a collaborative environment and structure; phases 4, 5, and 6, represent a systematic process for building expertise in the inservice participants; and phases, 7 and 8, bring the inservice activities to closure, and facilitate a wider range of student impact and spin-off projects through dissemination.

The eight phase model is designed to be implemented within the period of 1 year, with instruction of participants occurring during the last 10 months of the project. The eight phase approach has been essential to the success of Project TEAM and projected as essential for the success of the second project, Project TEAM—Secondary Mathematics. Each phase is described in more detail below.

Phase 1: Partnership Planning

During the initial partnership planning phase, project partners meet and discuss the collaborative potential for the sharing of resources and expertise. A Project Director is chosen, who then works to implement the eight phase inservice model (TEAM). A Project Evaluator is also chosen, who will monitor all phases of the project. To enhance joint planning, the Project Director works with a planning committee comprised of master teachers, local business technology experts, and university faculty. This committee has made a commitment to participate in the inservice project and provide input into the design, delivery, and evaluation of the project.

Each of the member institutions represented by the committee also contributes at least one topic and instructor to the three instructional phases of the project, and more if possible. The actual inservice instruction is planned for delivery at the resident institution of the expert instructor, so that integration of the topic into the classroom environment can be examined more effectively. By receiving instruction from daily practitioners, at the actual classroom site, inservice participants receive tutelage that focuses directly on classroom application and represents demonstrated success.

Phase 2: Program Design

During the program design phase, the specific inservice activities and schedule are planned. Project partners meet to discuss the basic and advanced educational technology topics that would be included, as well as identify the instructors and locations for each activity. These planning sessions are usually held in conjunction with breakfast meetings, and include as many of the members of the business community, master teachers, university professors, and administrators, as possible. A conceptual focus to the inservice design is essential. For example, in Project TEAM - Secondary Mathematics, the basic design of the project centers on the concept that students must be prepared to use technology and mathematics to accomplish real life tasks, as described in the Curriculum and Evaluation Standards established the National Council of Teachers of Mathematics (NCTM, 1989). To accomplish the above objective, the planning group identifies a schedule needed to facilitate instruction related to the mathematical and technological constructs that were identified for the project. In Project TEAM - Secondary Mathematics, project activities are spread over a ten month period and require participants to attend the following training periods:

- Thursday evenings
- One all day Saturday session per month
- A two day state educational technology conference
- A two day state mathematics conference
- Ten other scheduled technology related events

Phase 3: Participant Selection

If possible, participants for the inservice training should be competitively selected out of a pool of applicants. To increase the number of applicants in the offerings of Project TEAM and Project TEAM—Secondary Mathematics, participants were provided with several project related benefits. These benefits included a $500 stipend, $200 of software money, a scientific calculator or modem, a university computer account, and 3-6 hours of university graduate credit.

Applicants should be selected primarily on their potential contribution to their particular institution upon completion of the inservice training. To facilitate the selection process, and to maximize the quality of participants in the project, applicants should be asked to answer questions related to the following topics:

- How training would benefit the individual applicant.
- How training would benefit the applicant's colleagues.
- How training would benefit the applicant's school.
- How training would benefit particular students in the school.

Participants should be selected by a committee representing all involved in the project, through a thorough review and discussion of the applications. All participating institutions should have a relative number of "slots" for project participation. Representatives from each of the school districts can make individual recommendations for participation, but the selection committee should have the final decision related to which applicants will be selected for the limited number of participation slots.

Phase 4: Awareness Level Instruction

Approximately 25% of the project instruction is devoted to "awareness level" instruction, where participants explore general possibilities of technology application in the classroom. As much as possible, awareness level instruction comes at the beginning of the project. Awareness level activities include such overview activities as practitioner presentations, guest speakers, and software and hardware demonstrations. Local vendors also participate at this time by making group presentations related to their software and hardware products. However, sessions presented by practicing educators are the most interesting and helpful to the participants. For these teacher presented sessions, it is usually best to meet at the school site of the presenter, to help get a solid look at how the presenter is currently using the technology with students. Such on-site visits are much richer experiences, since basic questions such as classroom organization, room configuration, etc... can also be addressed during the technology training.

The awareness level instruction serves to build a fundamental knowledge in the participants related to how technology can be successfully used in education, and to spark their interest in particular applications which may be useful in their own classroom. Awareness level activities are as casual as possible, allowing participants to become comfortable with the project training, and their ability to be successful in the project.

Phase 5: Experience Level Instruction

The second 25% of the project instruction is devoted to hands-on "experience level" instruction, where participants work individually at a computer in a workshop setting. The initial focus of the experience level instruction is to help participants become competent in basic tool related applications, such as word-processing, databases, spreadsheets, and drawing packages. Building a solid base of practical experience is essential for the participants willingness to use and incorporate the more advanced applications, and the basic tool instruction should not be rushed. After this general instruction with basic tool applications, then further instruction during the experience phase focuses on more advanced applications such as telecommunications and hypermedia.

Instruction during the experience phase should not try to teach everything about a particular topic, such as hypermedia, but rather enough of a topic to allow the participant to eventually explore and continue work on their own during the later integration phase of the project. Participants have the opportunity to focus on a particular advanced application that they find useful or interesting during the integration phase of the inservice instruction.

Phase 6: Classroom Integration

The final 50% of instruction time in the project is devoted to helping participants develop a personal integration project that incorporates an advanced technology for classroom instruction. A significant amount of instructional time during this phase is devoted to "open lab" where instructors with special expertise in specific applications are available to help individual participants with their personal projects. It is also essential to help participants build their own personal network of individuals which they can draw upon to receive technical assistance and advice. This personal network will be a continuing resource that they can draw upon once the project training and support is completed.

To help build the participant's "personal network", social activities are also built into the training, such as brown bag lunches, field trips, or periodic presentations that are open to the local experts and at times the community. These social activities help build relationships between the participants and local experts, and the participants themselves. In addition, informal talk time, such as extended breaks or lunches, are built into all the structured training sessions to allow some informal conversation time for the general sharing of ideas and problems. Project TEAM and Project TEAM—Secondary Mathematics found that this informal time among professionals is where some of the best integration ideas came from, and was essential to the successful brainstorming of solutions to many technical problems as well.

Awareness and experience level activities are also offered periodically during the integration phase, to help brush up on general skills, and to continue to learn about successful applications of technology in the classroom. However, topics during the classroom integration phase primarily focus on assisting participants in developing and refining their particular classroom integration project.

It is important to note that the three instructional phases are structured to facilitate a gradual development of technical and professional expertise in the participant. During these three phases, participants move from a general awareness of what technology applications exist, to hands-on experience with certain technologies, to a very focused integration of a chosen technology to be integrated into their classroom instructional activities.

Phase 7: Project Closure

Following the project instructional activities each participant reports on the project they designed that integrates educational technology into the design and delivery of classroom instruction. This reporting is done through a computer aided presentation by each participant to the entire group of participants. In addition, each participant prepares formal documentation on their respective project for other participants, so that the projects may be replicated for implementation in several classrooms.

During this time, the formal project evaluator views the presentations as part of the overall evaluation of the inservice project. This allows the evaluator to observe the integrated curriculum projects that reflect the overall goals and objectives of the general inservice project. Further, this phase of the project allows the project directors to report back to the planning partners initially involved with the project. The actual integrated curriculum projects and the final report from the project evaluator constitute the major components for reporting on the effectiveness of the project.

In reality, if the inservice project is successful, it will not fully achieve complete closure, since it is anticipated that the participants will expand their integration activities, and continue to interact with each other and the project instructors. Additional funding sources are then explored to assist in the continuation of project activities, and to facilitate replications of the project with other participants, and possible spin-off projects related to the participants own integration projects.

Phase 8: Dissemination

The purpose of this final phase of the project is to share information gained in the project with a wide base of educators. First, there is considerable dissemination among participant institutions regarding individual integrated curriculum projects throughout the year long training program. In addition, in Project TEAM and Project TEAM—Secondary Mathematics, each participant has an E-Mail account through the university which allows them to continue to share information with the project directors, other participants, and interested professionals via the Internet system.

Traditional dissemination methods are also used. Formal papers can be submitted to professional organizations for inclusion in local, state, regional, and national meetings and manuscripts can be submitted to professional journals. Dissemination not only reports on the project's eight phases, but also on the integration projects developed by the participants themselves. Thus, dissemination should include both internal and external audiences, and should describe individual as well as group successes as they reflect the eight phase model.

Conclusion

The eight phase collaborative inservice model, called TEAM, worked very well during the two separate offerings of Project TEAM in the Omaha area. All the institutions involved have agreed that it is indeed more effective to approach technology inservice through a collaborative environment, where resources and expertise are shared. One of the most impressive aspects of this collaborative approach has been the emergence of a committed and energetic network of individuals who are continuing to share their expertise and collaborate, beyond of the initial two projects. This network of knowledgeable individuals is now a substantial resource to all initial partners in the project. Many of the individual integration products developed by the project participants are truly remarkable, and easily of commercial level quality. Some districts have even adopted individual participant projects as part of their overall school or district curriculum.

Perhaps what is most impressive however is the change in the individual participants themselves. Most, if not all, of the participants are now actively helping others to integrate and learn about advanced educational technologies, and have become local experts themselves in particular topics. The TEAM projects have provided them with the technical skills, and general enthusiasm, to help others use educational technology confidently and effectively in the classroom. It has been found that collaboration is indeed the key to successful technology inservice for teachers in today's schools. In essence, we have verified the old adage that sometimes all it takes for success is a little help from a friend, or in this case a "TEAM" of friends.

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Service technology training: Overview of Project ICIP

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Introduction

More than a decade ago, computer-based instruction (CBI) captured educators' attention amid promises that its widespread use would revolutionize education. Researchers subsequently concluded that, when used as a supplement to traditional instruction, CBI has a moderate positive impact on student achievement and attitudes (Kulik & Kulik, 1991; Kulik, Kulik, & Bangert-Drowns, 1985; Schmidt, Weinstein, Niemic, & Walberg, 1985-86; Tolman & Allred, 1991).

Despite its potential to improve learning, evidence suggests that CBI is largely unexploited. In a recent report on the integration of technology in our nation's schools, the U.S. Office of Technology Assessment found that over 50% of teachers had not used a computer for instruction (U.S. Congress, 1988). Furthermore, the vast majority of teachers have had little or no training to use instructional technology.

While preservice technology training efforts are beginning, graduates still feel ill-prepared to use computers in their teaching. A recent statewide survey of more than 1,000 student teachers in Michigan indicated that less than one-fourth felt that their teacher training programs had prepared them to use computers in their teaching (Michigan Preservice Technology Training Task Force, 1989). The lack of confidence on the part of preservice teachers may be due, in part, to the fact that preservice technology training focuses on computer hardware and the mechanics of running programs, with little emphasis on how to actually integrate technology use into instruction (Glenn & Carrier, 1989). Clearly, inservice training must be developed to continue to train teachers in the field to effectively integrate technolgy into their instructional programs.

While few would argue that ongoing inservice technology education is needed, there is little relevant empirical information related to effective integration training methods and content. Generally, teachers are introduced to technical operation of software, allowed to practice using the programs, then expected to go back to their classrooms and integrate the software into their instruction, often with little or no additional knowledge or support about how to do so. Although school systems frequently provide technical training, the burden of integration lies with the individual classroom teacher.

Project ICIP

In 1990, the Department of Special Education at Western Michigan University received a three-year grant from the U.S. Department of Education to develop and evaluate a new type of inservice technology training. The project, entitled *Instructional Computer Integration Preparation for Teachers of Handicapped Learners: A*

Comparative Study (Project ICIP), is designed to provide much needed empirical data regarding appropriate content and effective training procedures for inservice technology programs. The project serves both regular and special educators who teach students with mild disabilities. Utilizing a variety of data collection instruments, it is contributing important information about the impact of various training methodologies on subsequent technology integration efforts in the classroom. This paper will describe project activities and preliminary findings to date.

Method

Participants

Over the course of Project ICIP, nearly 100 teachers serving students with mild disabilities in grades one through six have been involved. In the first year, special education teachers from 42 school districts in southwest Michigan were invited to participate. Selection criteria included: a) teaching elementary special education students with mild disabilities, and b) having at least one Apple II series computer available for instruction. Thirty-eight teachers from 18 school districts were selected.

In the second year, more than 80 districts were invited to participate. Selection criteria were broadened to include regular educators serving at least one student with mild disabilities in a mainstream setting. Currently, 59 teachers representing 20 school districts are involved.

In both years, participants were randomly assigned to one of three training conditions: a) integration training, b) conventional training, and c) no training control.

Design

Project ICIP was designed as a single-factor control group design with replication during the first year anda two-factor control group design with replication during the second year. In the first year, the single independent variable was type of training: integration vs. conventional vs. no training (control). In the second year, teacher position, regular educator vs. special educator, was included as a second independent variable.

In both years, all teachers received several computer programs selected to meet their instructional needs. Additionally, teachers in the two training conditions participated in a series of three inservice training sessions at Western Michigan University over the course of the school year and engaged in follow-up interaction with Project ICIP personnel. Teachers in the control group received the same software, but did not attend training sessions or receive follow-up support from project personnel.

The dependent variable, subsequent technology integration, was defined as magnitude of software use, type of software use, amount of curriculum integration of software, persistence of software use, and teacher and student attitudes toward computer technology. Numerous instruments were used to collect information about the nature of technology integration in participating teachers' classrooms and are described in detail later in this paper.

Software Selection

Because prior research suggests that classroom teachers have little time to evaluate and select instructional software, Project ICIP personnel chose appropriate software for participants using information provided by the teachers. Prior to the first training session each year, participants completed a two-part paper-and-pencil Needs Assessment. The first part asked teachers to list the content areas they taught, to prioritize them in terms of instructional needs, and to identify the major objectives they addressed in each of their top three identified content areas. In both years, teachers as a group identified reading, language arts, and math as the three content areas in which they needed "different, better, or more instructional materials" and listed several instructional objectives within each area.

In the second part of the Needs Assessment, teachers were asked to list software programs which they had available to address each of the most frequently listed instructional objectives. Project ICIP personnel then systematically evaluated over 100 instructional software programs in the areas of reading, language arts, and math and selected several programs whichaddressed the needs of the majority of participants and which most participants did not already use or have access to in their classrooms.

In the first year, participants received:

1) *Math Masters: Addition/Subtraction* (DLM) and *Math Masters: Multiplication/Division* (DLM),
2) their choice of three language arts programs from a list of six including *Capitalization*, *Punctuation*, *Commas*, *Essential Grammar*, *Essential Punctuation*, and *Clue in on Phonics* (Gamco), and
3) two mini-authoring systems, *Odd One Out* (Sunburst) and either *Quickflash!* (MECC) or *StudyMate* (Compu-Teach).

In the second year, participants received:

1) one version of *Math Masters* (DLM) along with *Math Word Problems* (Weekly Reader),
2) *Reading and Me* or *Talking Reading and Me* (Davidson), along with *Read 'N Roll* (Davidson), and
3) their choice of one program from the following list of language arts tools: *Kidwriter* or *Kidwriter Golden Edition* (Spinnaker), *The Children's Writing and Publishing Center* (The Learning Company), *Publish It! 4* (Timeworks), *The New Print Shop* (Broderbund), or *Slide Shop* (Scholastic).

Training Sessions

Teachers assigned to integration and conventional training groups attended a series of three inservice sessions held in August, November, and February. During these sessions, they received selected software and participated in four hours of training activities. Although the time allotted to integration training and conventional training was comparable, the content differed greatly.

Conventional training was designed to emulate standard inservice sessions provided by school districts. It consisted of large-group software demonstrations, followed by hands-on guided practice, independent practice, feedback, and large-group sharing of impressions of the software.

Integration training, on the other hand, focused less on the technical aspects of the software and more on discussion of technology integration procedures. The sessions consisted of large-group software demonstrations, followed by short hands-on independent practice, then extensive discussion and sharing of instructional strategies and classroom management procedures to facilitate integration of CBI. During the first year, teachers in the integration group contributed to the design of the *Project ICIP Technology Integration Plan* which they used to develop instructional lessons integrating technology applications. Teachers involved in the second year of training are continuing to field-test the *TechnologyIntegration Plan* in their classrooms and sharing information with each other about effective and ineffective classroom practices.

Teachers assigned to the control group received selected software via personal delivery in August, then the mail in November and February. They did not attend ICIP training sessions or receive any assistance from project personnel regarding integration procedures.

Instrumentation

Several instruments were developed to collect information about the nature of CBI integration in participants' classrooms throughout the school year. These measures included computer attitude scales, confidence scales related to each software program, inservice training session evaluations, computer-based classroom observations, teacher and student interviews, daily computer use logs, and a computer integration measure.

Computer attitude scale. The *Project ICIP Computer Attitude Scale* was developed and field-tested using items gleaned from the literature. It was designed to measure general attitudes toward technology in society, self-confidence in using computers, attitudes about technology utilization in schools, and the importance of technology training. The paper-and-pencil measure was completed by all participants prior to the first training session in August and again at the end of the school year.

Confidence scales. At the end of each training session, participants completed paper-and-pencil five-point Likert-type scales designed to assess their self-confidence in two domains, using the selected software and integrating it into their instruction. A separate *Confidence Scale* was developed for each selected software program listing specific components of that program along with standard items related to instructional integration. Participants assigned to the control group were asked to complete the scales within the first four weeks after receiving each program.

Inservice session evaluations. Also at the end of each training session, participants completed a paper-and-pencil five-point Likert-type *Inservice Training Session Evaluation* form. The instrument was designed to measure satisfaction with training materials, procedures, and instructors. Participants in the control group did not complete this form.

Classroom observations. Each participating teacher wasobserved six times throughout the school year by trained, independent observers using a computer-based observation system. Participants were observed twice in the weeks following each training session. Teachers in the control group were also observed during these intervals. During each phase, teachers were asked to indicate dates/times when they would likely be teaching the designated content area (reading, language arts, or math) and when they would likely be using a computer for instruction. Using this information, observers conducted unannounced classroom observations lasting approximately one-half hour each.

Observers used portable laptop computers and the *Project ICIP Observation System - Version 1.3* (Bahr, Kenney, & Hannaford, 1991), an interval recording system, to collect field-based observational data. The system requires observers to watch the classroom for five seconds, then code a series of observed teacher and student behaviors for the next 55 seconds. This cycle continues for the duration of the class period.

Teacher interviews. Each teacher was interviewed three times during the school year, several weeks after each training session. Three different semi-structured interview protocols were developed to measure the nature of teachers' computer use, their use of the selected software, technical problems they encountered with the software (conventional and integration groups only), integration problems they encountered (integration group only), and implementation of the *Technology Integration*

Plan (integration group only).

Student interviews. During the first year, each teacher selected two special education students to participate in a face-to-face interview with Project ICIP staff. Seventy-six students were interviewed the first year, providing information about their perceptions of computer use in the classroom. Second year student interviews will be scheduled in 1993.

Daily computer use logs. To provide ongoing information about the types of software used in their classrooms and the time students spent using CBI, all participating teachers completed paper-and-pencil *Daily Computer Use Logs* at the end of each school day. Teachers recorded the titles of software used by students, the number of students who used each program, and the approximate amount of time each program was used during the school day.

Computer integration measure. This paper-and-pencil measure consisted of a series of questions designed to ascertain teachers' knowledge of what it means toeffectively integrate CBI. Questions also asked teachers to self-assess how well they currently integrate CBI into their own programs. It was administered to all participants at the end of the first year.

Preliminary Results

Although data are still being analyzed, several preliminary findings have emerged. First, results of *Inservice Training Session Evaluations* indicate that teachers are highly satisfied with both conventional and integration training procedures, materials, and trainers. It appears that training which adheres to general principles of effective inservice is valued by teachers, regardless of the actual content. It may be that, given teachers' busy schedules, the content of inservice sessions is less important than the mere opportunity to take time to explore software in the presence of knowledgeable colleagues. Teachers in the control group, who have not participated in training sessions, frequently report that they have difficulty finding time to look at the selected software.

A second finding is that teachers infrequently use the customization options available in instructional software programs. Although we attempted to select programs which included teacher options and editing capabilities, few teachers reported using these features. It appears that teachers prefer to use software which automatically progresses students through multiple levels, rather than having to select the appropriate level or customize the program by writing their own content. Project teachers indicate that, despite the flexibility available in mini-authoring systems, they do not prefer to use this type of software.

A similar finding is that teachers, as a group, rarely use the record-keeping functions available in many instructional software programs. While some teachers develop mechanisms and schedules for retrieving disk-based records, most do not monitor student performance during CBI sessions or check stored records after students complete CBI activities.

We also found that teachers use a variety of strategies to control access to their classroom-based computers. Many teachers pair students for CBI and some assign them roles. For example, one strategy several teachers use is to have two students work together with one entering responses while the other assists verbally. Then, when time to switch, the student who was verbally assisting moves into the keyboarding position andchooses another student from the class to take over the verbal assistance position. This system allows all students to work on the computer with at least two different partners and to play two different roles while using CBI. Teachers report numerous other strategies for managing the one-computer classroom.

Additionally, we found that there is still wide variation in the types of software used by elementary teachers. Although many teachers have access to relatively large collections, others have just a handful of programs. Most of the teachers involved in the project use CBI on a daily basis, but some use it in a variety of content areas while others restrict CBI to one or two subjects. While some teachers have consciously decided to quit using drill-and-practice programs, most still rely on stand-alone drill-and-practice programs. Teachers generally prefer programs which allow their students to work independently, rather than programs which require teacher assistance. This may be due to the fact that few teachers in one-computer classrooms have access to LCD or overhead display panels to facilitate large-group instruction. Most rotate all students through the available software one or two at a time rather than use a single program with a large group of students.

Implications

While conventional training is attempting to provide strictly technical information to teachers, integration training is educating teachers about what it means to integrate CBI into their programs and how to manage a computer-using classroom. We are encouraging teachers to use CBI, not as a freetime, filler activity or simply as a reinforcer for other work completion, but as a tool to assist in meeting instructional objectives. Teachers are trained to first identify their instructional needs, then select software which targets those needs. They are encouraged to develop systems for monitoring student performance during CBI activities and for retrieving student data after CBI sessions are completed. Furthermore, we are encouraging teachers to share CBI performance records with their students, and, in some cases, to allow students to assist in the monitoring process itself. During training, teachers share strategies with each other, view videotapes of teachers who have successfully integrated technology into their instruction, and develop and share technology integration plans. If teachers are expected to integrate CBI into their instruction, they must be provided the knowledge and skills to do so.

Project ICIP is supported by grant #H023C00107 from the U.S. Department of Education. The contents of this paper do not, however, reflect the policy or views of the Department of Education and no official endorsement should be inferred.

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Acknowledgements

We gratefully acknowledge the following individuals for their assistance with Project ICIP activities: Karyn Hoekstra, Susannah Krill, Mary Peterson, Holly Walls, and Amy Wilson.

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A field based inservice training system for educational technology staff development

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Introduction

This article describes an innovative university sponsored field based delivery system for providing educational technology staff development. Bemidji State University serves the teacher education needs of the northern one-third of Minnesota. This includes a rural area of over 58,000 square miles. Developing the educational technology skills of practicing elementary and secondary school teachers in rural Minnesota has provided opportunities for the development of new and innovative staff development approaches.

With the inception of any new innovation in education comes the need for practicing educators to develop the background and skills necessary to incorporate the new innovation into their teaching practice. With the growth of educational technology this need has out-paced educators ability to develop the necessary skills. A major problem has been the availability of adequate inservice opportunities. Much of the inservice activities to date have been limited to programming the computer and word processing. While these have their place in education, much of what is needed has little to do with these skills. Educators need to develop the ability to incorporate educational technology into their teaching and into their curriculum. There has been few effective staff development opportunities directed at the number of skills necessary to bring about an integrated use of computers in the curriculum and teaching. New approaches to the delivery of training are particularly important in rural areas where teachers cannot easily travel to on-campus training programs.

To meet the challenge of providing quality educational technology inservice programs to rural area teachers, Bemidji State University (BSU) in 1987 developed a field based training program to provide training that would meet the individual development needs of teachers, focus on the educational needs of local districts, be accessible to all teachers in the BSU service region, focus on the restructuring of the classroom, and develop collaboration opportunities for teachers, districts and BSU. To date over 400 teachers have participated in this educational technology staff development program and the program has been recognized state-wide as an innovative and successful staff development activity

Realizing that teachers are not all at the same level of educational technology development, nor need the same types and areas of staff development of inservice training, the field based training system allows for participation in activities that meet individual differences and needs. The training program provides for three major areas of staff development. In addition teachers may move from one component to another depending on their specific needs.

The three areas of staff development are:

1. developing educational technology skills
2. integrating educational technology into the curriculum, and
3. educational technology mentorship.

How the Field Based Training System Functions

A teacher at a local school district wishing to expand skills in educational technology selects one of the areas of staff development depending on specific needs. A proposal is developed with the participation of a BSU faculty member, and a local district support person (usually the district computer coordinator). The proposal identifies the outcomes of the inservice activity, selection of specific hardware and software (district must agree to support this inservice activity before BSU will accept the proposal), and a time-line for completion of activities. This proposal is then submitted to BSU for approval. The project is accepted by BSU and when completed up to three quarters of college credit may be earned.

The steps in completing a field based staff development activity in educational technology are as follows:.

1. Teacher selects an area of staff development (based on their needs)
2. Teacher develops a proposal identifying the outcomes of the staff development activity.
3. Teacher meets with local support person to obtain local support for the staff development activity.
4. Teacher submits proposal to BSU faculty sponsor for approval.
5. Project is approved
6. Teacher completes proposed staff development activities under supervision of local support person, with input from BSU sponsor as needed.
7. Results of staff development activity is shared with local school district.
8. Project report which includes a plan for using new skills in their teachng is submitted to BSU sponsor for evaluation.
9. Up to 3 quarter hours of graduate credit may be earned for the activity.
10. Teacher may repeat the process as needed to develop additional educational technology skills.

During the conduct of the project, the local teacher will have the support of the local district (arranged with BSU prior to the approval of the project), and support from the BSU faculty. In addition the field based training system provides for a mentorship opportunity for local teachers. This is one of the major strengths of the field based training system. As local teachers develop expertise in educational technology, they have the opportunity to further refine their skills by serving as local mentors for other teachers in process of developing their own skills. The use of local mentors greatly expands the capabilities of BSU to deliver inservice opportunities to a much larger population, and in addition offers additional development opportunities to local teachers by having them serve as local mentors.

Description of field based training system areas of staff development

The field based training system consists of three areas of staff development. The first component involves the teacher in the awareness and development of basic educational technology applications in teaching. The second component provides the teacher with the opportunity to develop an understanding to the potential curriculum innovations possible with the use of the technology in the educational program. The third component provides the framework necessary for the educator to develop outreach opportunities to share their expertise with other colleagues.

During the first component of the field based training system, teachers have the opportunity to develop background understanding of technology applications and their uses in instruction. This Educational Innovations component provides the educator with an indepth experience with the educational hardware and software that is available in her/his teaching area. With this experience comes the skills necessary to use technology effectively in teaching. The focus of this component of development is instructional. The teacher develops the ability to use technology in an instructional/management mode. The focus is on the applications of technology in the classroom. The many educational benefits on technology based teaching are experienced. At the end of this component of development the educator should feel comfortable in using some technology based teaching in their classroom.

Specific examples of activities at the Educational Innovations component include an indepth analysis of available computer software in the various subject / grade-levels. Educators become familiar with the different instructional uses of software such as utility programs, word processing, telecommunications, management, simulation, gaming, interview, and other instructional methods. Within each of these methods teachers develop skills in adapting software to classroom needs. The teacher options available on most modern educational software is also investigated. The individualization options of educational software and its enhancements to learning are also explored.

Educational management options using computers are also analyzed during the first component of the field based training system. Word-processing skills are developed along with the varied educational applications of word-processing. Developing worksheets, tests, communications with parents as well as record-keeping are all covered as a part of the management portion of the field based training system. The use of data file management in educational management is also discussed. Spreadsheets and their applications in education are also explored. Educators develop the skills to manage tests development, record keeping, grading, as well as improving their ability to communicate with other teachers, administrators, students, and parents.

Educators have the opportunity to develop a project directly related to their teaching area. They are encouraged to be creative in their utilization of educational technology in their project. Projects have ranged from the use of Hypercard in record keeping, to using Appleworks to drive a interactive laser disk, to the use of Grade Manager to keep student records to developing an awareness of computer applications in music and art education. Educators are encouraged to develop skills in an area of their interest or where they have a need to incorporate educational technology to solve an educational or management problem. The major outcome of component one is the development of skills that have direct benefit to the educator and can be adapted into their educational program.

The focus of the second component of the field based training system is the development of curriculum enrichment with computers . This component provides the educator with an understanding of the applications of technology based education into the curriculum. The activities go beyond the application of technology in teaching and develop skills in the integration / modification of curriculum to utilize the benefits of educational technology.

Curriculum modification to utilize technology has had little support from the classroom teacher. Historically teachers have been reluctant to involve their students in any technology related activities. The primary excuse for this reluctance has been the lack of skill on the part of the teacher. Where students have been exposed to technology based education, it has been most likely in a separate program using a central computer lab taught by a computer teacher or coordinator. Usually there has been little coordination between the computer lab experience and what is going on in the classroom. This has resulted in meager curriculum modification. The computer experience has been seen as a separate activity with little relationship to the students on going development. Component two offers educators with the opportunity to integrate technology based learning into the regular curriculum of the classroom.

During the curriculum enrichment component of the field based training system teachers develop skills in curriculum development. They focus on the potentials of technology based education and methods of modifying curriculum to include technology based education as a regular delivery method in the curriculum.

Component three provides the educator with the opportunity to refine their skills and develop skills in the inservice of colleagues in using technology in their teaching. This educational technology inservice cadre component of the field based training system addresses the ongoing need of staff development in education. A major outcome of this field based training system is the development of educators with the background and skills necessary to conduct staff inservice in the area of educational technology in their area. In rural areas this impact may be on a district wide basis, while in urban areas the inservice may be directed at a specific grade level or subject area. What ever the focus of the inservice it is important that the field based training system be receptive to changes in technology and provide for continuous upgrading of those involved in the process.

The educational technology inservice cadre will provide a needed service to the educational community by making staff development available to a greater number of educators in addition to providing encouragement to those reluctant to incorporate technology based opportunities to their students. Having field based individuals involved in the updating of educational technology skills provides may benefits. Classroom teachers who have been successful in using technology in teaching provide an excellent field based training system to other teachers in their district. They have an understanding of the limitations within their schools and are able to demonstrate strategies for overcomming those limitations. This does much to reduce many of the excuses that some teachers use. Another major benefit is that field based teachers have the opportunity to first hand evaluate the effectiveness of computer applications in the classroom. As a member of a cadre, they will have the opportunity to share their observations with other cadre members. This sharing of ideas will enhance the utilization of educational technology in education.

Outcomes

Input from participants as others have identified several areas of positive outcomes from this field based training system for educational technology staff development. The following identifies some of the benefits of the system to the teacher, the local school district and to BSU.

Benefits to the teacher include:

1. Opportunity to develop educational technology skills that can be used in the .
2. Skills in upgrading and restructuring their curriculum.
3. Opportunities and framework that supports sharing of skills and ideas with fellow teachers.
4. Opportunity to upgrade teaching skills in a convenient time frame.

5 Opportunity to earn graduate credit in an area of professional development need.
6. Developing skills in using resources that are available after the training ends.

Benefits to the local school district:
1. Capability of offering high quality and cost efficient staff development opportunities to a small number of teachers.
2. Input into the staff development activities of their teachers.
3. Greater utilization of educational technology resources in the school.
4. Site specific training opportunities
5. Forum for sharing staff development needs with higher education.

Benefits to BSU
1. Structure to meet the needs of many distant learners
2. Better utilization of university resources.
3. Ability to deliver high cost training at reduced cost to the institution.
4. Forum for addressing local school needs.
5. Opportunity to provide leadership in service region in area of educational technology.
6. Opportunity for the recruitment of graduate students.

In addition the field based training system provides a framework for the delivery of educational technology based staff development. That framework provides for the training of trainers to be sensitive to the instructional innovations that educational technology has brought to education as well as to the curriculum. In addition, the field based training system provides for interaction among the participants that will enhance communication within in and among districts. An ongoing dialogue on the issues related to technology in education as well as the basis for an integrated staff development program provide a field based training system that can be used in other educational program areas as well. Making quality staff development opportunities available to educators is a major concern of teacher education institutions. Developing a framework to facilitate and ensure the delivery of quality programs is the major outcome of this staff development activity.

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Effects of teacher involvement in curriculum development on calculator instruction and students' mathematics achievement

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The use of technology in mathematics education has the potential to shift the focus of instruction from an emphasis on manipulative skills and algorithms to an emphasis on developing concepts, relationships, and structures (Corbitt, 1985). If allowed, technology could play two powerful roles in the change process: one as a catalyst for change of curriculum and instructional strategies and another as a resource that could facilitate the transformation of teaching and learning (David, 1990). In particular, the integration of calculators into the mathematics curriculum mandates that the computational focus of the curriculum be eliminated and, at the same time, provides the power for an investigative, problem-solving approach to be incorporated. The union of curriculum reform and technology creates a much more powerful force for change that either does alone.

The National Council of Teachers of Mathematics (NCTM) has attempted to tap this powerful force for change by formally renewing its efforts to encourage mathematics educators to reform the curriculum and incorporate more technology into classroom instruction and activities. The organization has challenged educators to change both the instructional and curriculum components in two of their recent publications. The *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989) emphasizes problem solving, higher-level thinking, and communication and provides criteria for incorporating calculators into the school mathematics curriculum. The *Professional Standards for Teaching Mathematics* (NCTM, 1991) advances the vision of high-quality instruction through the use of technology. It is now the task of educators to determine effective methods for producing these curriculum reforms and implementation changes in schools.

The literature on educational change indicates that teacher involvement in the planning and development stages of an innovation is a significant factor in its implementation. Stein and Wang (1988), for example, have examined curriculum development and implementation and found that innovations may produce disappointing outcomes, not because of inadequacies of the innovative idea, but because of lack of teacher involvement in the development of the innovation. It is through the teaching process that classroom teachers create meaning for a new curriculum (Morin, 1986). In the final analysis, it is classroom teachers who implement the curriculum, adapt it to the needs of their students, and inject into it their individual teaching styles. Quite simply, a new innovative curriculum is not what a professional reformer has designed but rather what the teacher has made it. With regard to technology and mathematics education, the question remains whether a traditional approach to teacher inservice is adequate to create the necessary changes or whether a new approach which more actively involves teachers in the development of the innovation is necessary to change implementation processes.

The purpose of the present study was to investigate the effects of teacher involvement in curriculum development on (a) teacher implementation of calculators in the classroom and (b) student mathematics problem-solving achievement. Since it was hypothesized that differences between groups of teachers on classroom calculator implementation could merely indicate differences in the groups' attitudes toward calculator use, it was necessary to account for teachers' attitudes toward calculators when investigating the effect of teacher involvement on the implementation process. Therefore, three groups were specifically compared for this study.

The present study compared the implementation process of teachers who had high attitudes toward calculators to teachers who had low attitudes toward calculators, and compared teachers who were involved in curriculum development with teachers who were not involved in that aspect of the program. Group 1 consisted of teachers who were found to have high attitudes toward calculators and were members of curriculum development teams which were developing calculator mathematics activities. Group 2 consisted of teachers who also were found to have high attitudes toward calculators but were not members of a curriculum development team. Group 3 consisted of teachers who were found to have low attitudes toward calculators and were not members of a curriculum development team. Calculators were issued to every middle school mathematics student so the technology was present in the classrooms of all three groups of teachers. It was hypothesized that teachers' attitudes toward calculators as well as teacher involvement in curriculum development would affect the implementation process and the frequency of calculator use in classrooms. Of particular interest, was whether teacher attitude toward calculators was the overriding factor which affected the implementation process, or if other factors (i.e., teacher involvement in curriculum development) also played important roles.

The problem-solving achievement scores from students of each of the three groups of teachers also were compared to determine what effect teacher involvement in the development of the innovation had on student achievement. It was anticipated that the students from the curriculum development group would score significantly higher on the problem-solving test than the students of the other teachers because of the problem-solving emphasis for the calculator activities that were being developed at the time.

Methods

The subjects were 45 middle-school (grades 6-8) mathematics teachers from a large, urban/suburban school district located in a major metropolitan city in the south central region of the United States. These teachers and their students are part of a nationally funded project involving the implementation of calculators. Each middle-school mathematics teacher in the district received 12 hours of inservice training on the use of calculators, and each of their students was issued a calculator. The data for this study was collected during the first year of the project.

Sixth and seventh grade students were issued Texas Instruments Math Explorer calculators, and eighth grade students were issued TI-30 SLR+ scientific calculators. Students were to be allowed to use their calculators in any class and to take them home for homework purposes. It was the intent that students experience "ownership" of the calculator so that their confidence and trust in their ability to use the instrument would be heightened and would encourage the students to experiment more and investigate mathematical ideas.

The Calculator Teacher Attitudes Scale (Bitter, 1980) was used to measure teachers' initial attitudes toward calculators and to identify three groups: (a) teachers who had high attitudes toward calculators and were members of a writing team which was developing calculator mathematics curriculum (Group 1), (b) teachers who had high attitudes toward calculators and were not members of a writing team (Group 2), and (c) teachers who had low attitudes toward calculators and were not members of a writing team (Group 3). The calculator attitude scale was administered to the teachers prior to the calculator inservice training. No teachers on the writing teams were found to have low attitudes toward calculators.

Each teacher was observed four times during the school year by trained classroom observers. Teachers had no indication as to when they would be observed. There were a total of sixty 45-minute observations for each of the three groups of teachers (180 total observations). The Observation Rating Scale for Calculator Implementation (ORSCI) (Williams, Waxman, & Copley, 1991) was used to measure the amount of calculator use, to assess the quality of the calculator instruction, and to identify the kinds of activities in which students are involved when they use calculators. Seventeen indicators measured the quantity and quality of calculator instruction and use. Mean scores for each teacher were computed for every item. From those scores, mean scores for each of the three groups were computed for each indicator and analyzed using one-way analyses of variance.

In addition, math basic skills and problem-solving achievement of the students of each of the teachers was assessed. A modified version of the Essential Elements of Elementary Mathematics Test (White, 1986) was administered in early fall as a pre-achievement measure and was used as a covariate in the analysis. The Four-Step

Problem Solving Test (Hofmann, 1986) was administered in late spring as a post-achievement measure. An analysis of covariance (ANCOVA) was used to compare the three groups on student problem-solving achievement.

Results

One-way analyses of variance were used to compare the three groups of teachers on each of 20 items and on the overall score from the Calculator Teacher Attitudes Scale. Statistically significant (p<.01) differences were found for 13 of the 20 items and for the overall score. The Duncan post hoc test was used to determine where the differences between the groups were. In each of these 14 cases, no significant differences were identified between Groups 1 and 2 (high attitude groups), but Groups 1 and 2 scored significantly higher than Group 3 (low attitude group). It was determined that the effort to select groups of teachers with differing attitudes toward calculators had been successful.

Of the nine indicators used to assess classroom instruction with calculators for each of the 45 teachers, four revealed significant (p<.05) differences among the three groups of teachers (Table 1). Teachers involved in the curriculum development (Group 1) were observed significantly more often than those teachers not directly involved in the curriculum development process (Groups 2 and 3) to (a) explain the relationship between the calculator procedure and the paper-and-pencil algorithm, (b) stress the use of the calculator as a "time-saver", (c) stress the use of the calculator as a "problem-solving" tool, and (d) initiate use of calculators in the classroom. For each of these four indicators, no significant differences between the two non-writing groups (Groups 2 and 3) were found. For the three groups in this study, it appears that teacher involvement rather than attitude toward calculators or teacher calculator inservice is the major factor affecting classroom implementation.

No significant (p<.05) differences among the three groups were found for the percentage of students who brought their calculators to class or for the percentage of class time calculators were used. For these three groups, it appears that neither teacher attitude nor teacher involvement affect the quantity of student calculator use.

Three of the six classroom calculator activity indicators revealed significant (p<.05) differences among the three groups. In classrooms of teachers who were involved in creating calculator materials (Group 1), students were observed significantly more often than those in classes of teachers not directly involved in curriculum development (Groups 2 and 3) to use calculators for (a) exploration and induction activities, (b) solving routine word problems, and (c) self-checking and verifying answers. No significant differences between the two non-writing groups (Groups 2 and 3) were found for any of the six indicators.

These findings indicate that active teacher participation in curriculum reform involving technology rather than teacher attitude toward calculators is a major factor affecting classroom calculator implementation and teacher selection of student activities. Of concern, however, is the low percentage of time students in any of the three groups were observed using calculators for (a) exploration and induction activities, (b) solving routine as well as non-routine word problems, and (c) games. Few observations of these activities should indicate that students are not being given sufficient problem-solving opportunities. The findings from the problem-solving achievement measure support this assumption.

Significant (p<.05) differences among the adjusted student mean scores of the three groups were found on one of the four scales of the student problem-solving measure (Table 2). On the scale, understand the problem, the adjusted means of Groups 2 and 3 were higher than that of Group 1. No significant differences were found on the other three scales: select an appropriate strategy, find a solution, or extend the problem. The adjusted mean student total scores of Groups 2 and 3 were also significantly higher than Group 1. It should be noted that the highest possible mean score for each scale was 10. Hence, each group (on an average) successfully answered only 4 out of 10 questions for each scale.

No significant differences were found when the problem-solving achievement data was analyzed by grade level. Also, the group by grade interaction was not significant.

Discussion

It appears that teacher involvement in the development of mathematics calculator curriculum has an immediate positive effect on teachers' instructional strategies, but not on students' problem-solving achievement. In fact, concentration on the implementation of calculators during the initial stages of the innovation development appears to have a negative effect on problem-solving instruction. These results indicate that the curriculum developers may have been so focused on identifying opportunities for calculator use that they did not include sufficient non-routine problem-solving activities. In contrast, those teachers who concentrated less on calculator implementation appear to have better prepared their students for solving non-routine problems. Increased focus on using the calculator for exploration and problem-solving activities is needed.

Research summarized by Loucks-Horsley and Hergert (1985) indicates that it takes between three and five years for the change process to become totally incorporated into a teacher's instructional approach. According to Ornstein and Hunkins (1988) sufficient time must be allowed for

Table 1
Analyses of Variance on Classroom Calculator Implementation, Amount of Student Calculator Use, and Student Activities

Survey Item	Group 1 n = 15		Group 2 n = 15		Group 3 n = 15				
	M	SD	M	SD	M	SD	F	p	Post Hoc
Classroom Instruction									
• Allows Ss to determine appropriate use of calc.	.47	.21	.37	.21	.30	.22	2.37	.105	
• Emphasizes importance of estimation with calc.	.13	.21	.03	.09	.05	.10	2.09	.137	
• Explains relationship between calc. & paper-and-pencil algorithm.	.25	.16	.07	.11	.07	.11	9.52	.000	1>2,3
• Stresses use of calc. as "time-saver".	.25	.16	.13	.13	.12	.16	3.44	.041	1>2,3
• Stresses use of calc. as "problem-solving tool".	.22	.16	.10	.13	.07	.11	5.10	.010	1>2,3
• Demonstrates use of calculator.	.27	.24	.13	.19	.12	.16	2.58	.088	
• Initiates use of calc.	.45	.24	.27	.26	.23	.18	4.00	.026	1>2,3
• Ss use calculators during tchr demonstration.	.28	.28	.20	.17	.15	.18	1.44	.248	
• Ss initiate use of calc.	.35	.16	.30	.29	.30	.17	0.28	.760	
Student Calculator Use									
• Percentage of Ss who have calculators at their desks/tables.	.74	.14	.61	.20	.63	.12	3.08	.057	
• Percentage of time Ss (who have calculators) use them.	.46	.15	.38	.21	.38	.17	0.86	.431	
Student Activities With Calculators									
• Use calculators for computation.	.63	.23	.47	.28	.45	.24	2.47	.096	
• Use calculators for exploration/induction activities.	.20	.17	.05	.10	.05	.10	6.75	.003	1>2,3
• Use calculators for solving routine word problems.	.27	.20	.13	.19	.07	.15	4.84	.013	1>2,3
• Use calculators for solving non-routine word problems.	.12	.13	.03	.09	.05	.10	2.49	.095	
• Use calculators for self-checking/verifying answers.	.40	.16	.27	.22	.17	.18	5.79	.006	1>2,3
• Use calculators for games.	.05	.10	.02	.06	.00	.00	1.96	.154	

Note. df for all items = 2,42.

an innovation to be developed and incorporated before an accurate assessment of its long-term effects on students can be determined. With this in mind, increased teacher attention needs to be directed toward calculator use in problem-solving situations.

Acknowledgements

Support for this research was provided in part by a grant from the U. S. Department of Education, Dwight D. Eisenhower Mathematics and Science Education Program, award number R168D00311. Opinions and views

Table 2
One-Way Analyses of Covariance on Scales of Student Problem-Solving Achievement: Mean Scores Adjusted

Survey Item	Group 1 n = 15		Group 2 n = 15		Group 3 n = 15				
	M	SD	M	SD	M	SD	F	p	Post Hoc
Understand the Problem	4.00	.11	4.33	.11	4.37	.11	3.25	.049	2,3>1
Select an appropriate strategy	3.82	.11	3.99	.11	4.17	.11	2.60	.087	
Find a solution	3.74	.10	4.00	.11	4.05	.11	2.53	.092	
Extend the problem	3.59	.10	3.83	.11	3.97	.11	3.20	.051	
Total score	15.15	.38	16.15	.40	16.56	.40	3.41	.043	2,3>1

Note. df for all items = 3,40.

expressed in this paper do not necessarily reflect those of the granting agency.

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AZTEC: An inservice technology lab for rural vocational/technological teachers

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Institutions of higher education with a mission to provide teacher education to rural communities have a distinct challenge when the training includes technology education. At Northern Arizona University, an in-service technology lab known as AZTEC (Arizona Technology Education Conceptions) was created to provide technological updating to rural Arizona vocational teachers. The uniqueness of the technology lab was its intended capability to serve as an on-site multimedia laboratory for visiting educators and a transportable demonstration lab for 15 rural county secondary schools covering 100,000 square miles. The question of upgrading teachers technologically in geographically distant districts in an accessible and functional manner has perplexed many teacher trainers.

Technology Training for Teachers

Business and industry across the United States have criticized education for not training youth to enter the job market with current technological skills. The foundation of such a goal demands that the trainers of young people, the teachers, be skilled in facilitating the utilization of technology. As noted, "Education has been one of the last professions to adopt technology as an integral component of the teaching-learning process. In too many classrooms, the lecture, textbook, and chalkboard constitute the major instructional delivery system" (Beardslee & Davis, 1989). Quality training for teachers has been cited as one of the most important factors in the advancement of education (Bruder, 1988), and the incorporation of technology into the education or teachers has been cited as a primary goal (U.S. Department of Education, 1992). A variety of panels on educational excellence has recommended that faculty utilize active modes of teaching such as interactive technology which would require students to take more responsibility for their learning (see, e.g., Study Group on the Conditions of Excellence, 1984).

Why have teachers not embraced technology as eagerly as one would expect? Research supports that teachers teach as they were taught, few teachers have skill in utilizing technology outside of traditional audio-visual media and basic computer applications, and school curricula predominately involve text-based materials (Taylor & Cunniff, 1988; see, also, Weber & Puleo, 1988). However,universities and colleges often have technological resources which should be utilized in the training of future teachers. These resources range from electronic networks to computers to multimedia. Such resources are powerful teaching and learning tools but are not always accessible or centralized for academic instruction. Reynolds and Anderson (1992) pointed out the need for changes in teaching and learning opportunities through internal and external partnerships of technological resources, and Martorella (1989) reminded universities that teachers will require both pre-service and in-service training programs in order to implement technological tools into their classroom activities.

The research on computers and computer-related technology utilized by secondary teachers has increased since 1975. Some studies have indicated negative teacher attitudes towards instructional computer use (see, e.g., Lichtman, 1979; Walker, Keepes, & Chang, 1992). Other research has reported increasing interest and enthusiasm on the part of educators (Newman, 1982; Slowiczek, 1987). Some rural students have received instruction in technology through the nontraditional route of mobile facilities centers. McCauley (1982) reported the mobile center as a cost effective delivery system to sparsely populated areas with "facility mobility . . . of major importance because it provides access to education programs in the student's own school district" (p. 66). However, there is limited research on the specific needs and directions of technology in rural education as it relates to pre-and in-service education (Chambers & Bork, 1980; Jansen, 1988; Lysiak, 1976; McGrath, Thurston, & McLellan, 1990).

A Rural Teacher and University Exchange Project in Pennsylvania addressed major problems facing rural educators (McKee & Perkins, 1992). The following concerns were identified which affect in-service technology training for rural teachers: (1) teacher isolation and therefore fewer in-service opportunities, (2) isolation from the local community where parents view education as an obstacle and not an opportunity, (3) fragmentation of high school curriculum and lack of content integration, and (4) lack of incentives or rewards for excellence in the classroom or from professional growth. Research in rural settings has pointed out that technology resources consist mainly of computers and that computers are primarily utilized for word processing in the classroom (see, e.g., Peltier, Foldesy, Holman, & Matranga, 1992). More recently, Arizona rural school teachers have indicated a strong interest in courses or in-service training on computers and other technology (Bush, 1990; Bush, 1991), and other rural school districts around the nation have increased opportunities for professional development because of technology (Committee on Education and Labor, 1991).

Purpose of AZTEC

In 1991, the Arizona Center for Vocational/Technological Education at Northern Arizona University identified technology training for rural secondary educators as a priority. The AZTEC lab was implemented to provide on-site and field-based opportunities for teachers to explore and experiment with multimedia hardware and software not available in rural school districts. With the goal to support the infusion of technology into vocational/technological education in the state, AZTEC was promoted as a small learning lab where multimedia could be viewed as a supplement and alternative delivery to traditional teaching and learning. Teachers were encouraged to preview prepared lessons in a variety of vocational disciplines and to determine potential usages for technology by experimenting with multimedia. The lab was not intended to change primary teaching styles but offered an understanding of technological choices for student learning.

A variety of multimedia equipment is available in the AZTEC lab on the campus of the University. This equipment is also available for check out to rural school districts on a competitive basis. A hypergraphics system, video equipment, multi-dimensional computer systems, and visual presentation equipment are examples of the most frequently utilized equipment. Most of the rural schools and their vocational/technological teachers have not had access to technological equipment in the classroom, and their familiarity with technology in general is limited.

First-Year Results

During the first year of the AZTEC lab, a survey was utilized to collect data. Lab participants were requested to identify their position and rate AZTEC equipment as to personal interest and utility in participants' educational settings. Additionally, two open-ended questions were asked: (1) What additional equipment would you like to see in the AZTEC lab? and (2) What was your overall impression of the AZTEC lab?

AZTEC lab endeavors in the first year have consisted primarily of demonstrations and small group hands-on activities ranging from three to thirty vocational/ technological teachers. Short demonstrations, ranging from 30 minutes to 2 hours, and small-group in-service activities, ranging from 3 hours to 2 days, have been offered to 157 teachers. With educators inviting their students and administrators to the lab, the number of people served increased to 390. The variety of interests ranges from teachers of rural incarcerated youth programs to teachers in the fields of applied mathematics, business education, and home economics. Additionally,AZTEC equipment was implemented into two summer in-service institutes in which teachers focused on the integration of academic and vocational education.

Rural vocational/technological teachers have requested demonstration of the Hypergraphics system most frequently. The Liteshow system has been noted as the technology which has most direct applicability and usefulness in teachers' classrooms. The Hypergraphics system and the pad camera (a mounted, lighted digitized camera which enlarges objects in 3-D) are equipment most frequently requested for future loan to rural school districts.

Participants in the AZTEC lab support the University's innovation and the philosophy of the lab. The teachers believe that with continued in-service training they can harness the power of multimedia to change their classrooms into more dynamic experiences for students. Moreover, teachers have indicated a belief that multimedia can aid in the development of critical thinking of students. As one teacher stated, "We don't have the money for this type of equipment but when we do, at least I have had the opportunity to learn about multimedia resources and will be prepared with a purchase order in hand!"

Problems Encountered

A major problem encountered in implementing the AZTEC lab was the ordering of equipment. The University purchasing and accounting systems at that time allowed for orders from the state-account bid lists with specific vendors. Therefore, AZTEC requests external to the bid list were rejected at first. Once the situation was resolved, vendors both on and off the bid list were engaged, and AZTEC was able to order specific equipment at competitive prices.

As expected, time was a critical component to the process. AZTEC equipment was purchased from federal vocational grant monies which were to be returned to the general fund if not encumbered within a one-month period. In order to utilize the monies, equipment needed to be ordered with the condition that the equipment be delivered to the University within 75 days. Unfortunately, two multimedia systems were not delivered within the deadline and therefore orders were canceled.

Since some of the equipment had not been demonstrated to AZTEC personnel and was ordered based on telephone conversations and written literature, some systems were not complete upon delivery. Consequently, the AZTEC lab has required additional purchases beyond the initial funding. It is recommended that future purchases involve a longer period of investigation and direct access and demonstrations to equipment.

What's Next?

Rural teachers in Arizona utilize computers in their classrooms; however, multimedia equipment is not as available. The collection of data which will clarify and more accurately identify the needs of rural vocational/technological educators will be accomplished in the future through a revised survey and a restructured process of data gathering. A multitude of questions needs to be answered. For example, "How has technology impacted rural vocational/technological teachers and students?" Additional studies need to be conducted which offer a greater understanding of the quality of education in rural schools and the relationship to technology. What kinds of technology would be most beneficial to teachers in rural settings? What technology would provide the most cost effective interactive delivery system? How can equipment and delivery systems be funded? Will technology remove the "isolation" factor in rural education?

By providing both on-site and field-based multimedia experiences for rural vocational/technological teachers, the AZTEC lab is filling the void on a temporary basis. On the other hand, participation in and knowledge of AZTEC has allowed both teachers and administrators the opportunity to better plan for the use of school district federal and state vocational/technological funding. Traditionally, rural school district grants in Arizona have been written by administrators without teacher input or collaboration. As a result of participation in AZTEC activities, teachers have a better understanding of technology and have shared this knowledge with administrators. Moreover, this understanding has led to more effective planning in vocational/technological education.

In its first year of operation, AZTEC has accomplished its primary goal and has been well received by 15 rural school districts in Arizona. Future AZTEC goals will include the following: (1) To assist rural vocational educators in utilizing technology in integrated academic/vocational courses, (2) to aid vocational educators in planning and implementing the levels and strands of the Arizona Vocational/ Technological Curriculum Model, (3) to disseminate technological information on a regular basis, and (4) to provide training opportunities to the pre-service technology education program at the University.

AZTEC's commitment to rural vocational education assists the University in meeting its mission of in-service training to rural teachers. As one teacher pointed out, "No other institution offers us a technology lab for a day or more importantly allows me, the teacher, an opportunity to borrow multimedia equipment in the future." Teachers have commented that multimediaresources help organize the learning environment to stimulate creativity, self-motivated learning, and self-discovery. The AZTEC concept has been successful thus far, and its operation is expected to increase in the upcoming academic year.

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Computing and technology: What an administrator needs to know

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School principals play a crucial leadership role in bringing new innovations into the classroom. While the building principal often drives the movement to introduce, support, and institutionalize curriculum innovation, in many instances, administrators play a more passive role, supporting teachers' efforts to change the curriculum, playing an encouraging but less active role. The introduction of computer technology as an integral part of the instructional program requires the *active* leadership of school administration because of its multifaceted nature and the intense budgetary requirement. This paper suggests steps to be taken to provide school principals with the tools necessary to take this active leadership.

In the 1970s it was predicted that computer technology was about to revolutionize American education. By the late 1980s, the promise faded and people began to ask, "What revolution?" (Tucker, 1985). Most classrooms of 1992 remain essentially unchanged by computer technology; to understand why this is so, we must examine the means by which an innovation becomes an integral part of classroom practice.

One of the primary roles of the school principal is traditionally considered to be leadership in curriculum development and innovation. The principal *should* play an active role in the introduction of a curriculum innovation. However, it is often an interested teacher who has experienced an innovation during a course or workshop and wishes to try it out in his/her classroom introduces that innovation in the classroom. A principal may support such innovation and encourage other teachers to try it if it is successful. Thus a new teacher who has received a good grounding in whole language instruction, for example, may introduce this idea to a school by first using it in his/her classroom and then helping others introduce the idea to their classrooms. The principal supports the innovation by providing for inservice opportunities or courses for interested teachers. The teacher is the agent of change and the principal plays a supportive but passive role.

While this model has proven successful in many arenas, when the innovation requires significant budgetary commitment, the leadership of the administrator is not only necessary, but required. What model of innovation, then, works for technology in the schools?

Computing in Schools: The Story of an Innovation

Computer technology was first introduced into the precollege classroom in the mid and late 1970s in the form of computer aided instruction (CAI) programs running on mainframes housed on college campuses. The initiative for this innovation came, for the most part, from university centered research projects. Schools interested in innovation were sought by the university researchers and school boards or school principals volunteered classrooms to be part of studies of the efficacy of computer aided instruction. The actual number of classrooms affected was small and there was little substantive curriculum change as a result of this early computer use (Taylor, 1980).

With the development of the desktop computer, computing moved with more force into the school environment. A cadre of teachers, who were also computer hobbyists, brought computers into schools in the late 1970s and began to devise ways to use them to enhance their instruction. These early computer innovators often sought desperately to find a place for this new technology in an already crowded curriculum.

A lack of good software greatly hampered the effort to make computing a viable part of the existing curriculum and the fact that most new microcomputers came already equipped with BASIC led to the creation of an new subject area within the curriculum, computer literacy, which included coursework in computer history and elementary computer programming using BASIC. Teachers who took on the task of presenting this new subject to students were often those same self-taught, computer hobbyists, with little if any specific training in the area. It was all too often assumed that mathematics teachers could teach computer literacy or that any one who could *use* a computer could teach about it.

Thus the computer moved from its early role as a medium for instruction and it became the main focus of the instruction. As so often occurred in the past, the medium became the message (McLuhan, 1964). It was claimed that teaching children to be computer literate would prepare them for a future that was certain to be dominated by technology.

The 1990s brought a more enlightened view of computers and technology. No longer viewed as an end in itself, computer technology is now seen by most educators as a medium for presenting instruction to students, as a tool to enhance both teaching and learning. The computer is now used primarily as an instructional tool to present material in ways not possible by traditional means.

This new view of computing requires a change in pre-service and inservice education courses for both teachers and administrators. No longer is the primary concern only the teacher who is going to "teach computers." If the computer is to be used for classroom instruction, every teacher needs training and exposure to computer technology as a medium for presenting instruction and every administrator needs training in the variety of instructional uses of technology.

Schools of education are beginning to offer courses for pre-service teachers in the use of computers as instructional tools. State Departments of Education are beginning to require such courses for certification. Sinceteachers tend to teach as they were taught, these courses are most effective when teachers have the opportunity to see the use of computing demonstrated by the course instructor and have the chance to observe a teacher using computing in a classroom with children (Cunniff, 1990). It is very difficult, if not impossible, for a new teacher to introduce technology into his/her classroom if she/he has never seen technology used in a classroom. The modeling aspect of the computer pre-service instruction is a very important factor, one that is often overlooked in the preparation of new teachers (Cunniff, 1990).

If we assume that schools of education are adequately preparing teachers to use computers and computer technology as instructional tools in the classroom, why then is computing not reaching the schools and not having any noticeable effect on the quality of instruction in the schools? To answer this question, it is imperative to look at how educational innovation moves from being innovation to becoming institutionalized. The principal can serve as a instructional leader by recognizing the training and talents of a new teacher and encouraging her to try these new ideas in her classroom and finally by encouraging the spread of the innovation throughout the school. Actually this model is a good one because the innovation springs from within the organization and its propagation is the result of "teachers teaching teachers" rather than have outside experts come in and teach.

This has not been a successful model for introducing computer technology to the classroom. Computers and associated technology require such an extensive investment in hardware and software that teachers coming from pre-service programs with some training in use of computers as instructional tools are often forced to revert to traditional instruction because of lack of necessary resources. Teachers interested in introducing computers to their teaching usually lack the budgetary power necessary to obtain required equipment. The successful introduction of computer technology requires the active leadership and commitment of the school principal.

The Principal's Role

The answer for technology innovation is for the person with budgetary discretion to make the decisions concerning the introduction of technology into classrooms. The principal has both the leadership position and the accompanying power to be a successful innovator. But this can only happen successfully if the principal has a broad knowledge of the possibilities offered by the new technology for the improvement of instruction.

I contend that if computing is ever to become successfully integrated into the learning and teaching process of a school, the principal needs to be a fluent user of computing for educational purposes. He/she also needs to be cognizant of the instructional uses, pedagogical implications, and curricular effects of using computing in the classroom and needs a thorough grounding in the research on educational technology and innovation. This fluency can be developed through a planned program of experiences with computing in an educational environment.

The Computer as an Instructional Tool: A Course for Administrators

I recommend that every school administrator-to-be should be required to take a course in the instructional uses of computing as part of his/her administrative coursework. At the end of such a course the administrator-in-training would:

1) be a fluent user of a range of computers and hardware for educational applications.

2) be able to plan lessons for several curricular areas integrating computer software appropriate to the lesson and grade level.

3) be able to use a word processor to produce a variety of documents.

4) be able to discuss the current research concerning the use of word processors in writing instruction.

5) be able to create a database and design a classroom activity using that database.

6) be able to use several graphics application software for production of certificates, signs, and graphic displays.

7) be able to use teacher productivity software such as gradebook programs and test generators to design classroom related materials.

8) be able to discuss the curricular implications of using programming in a problem-solving environment and be able to write a short program in LogoWriter.

9) be able to discuss the integration of several computer programs into the school curriculum at a selected level.

10) be able to analyze research reports on the effects of computers in the classroom.

To achieve these objectives effectively, the course must require active use of a wide range of educational software and a variety of computer operating systems. The course must be designed to involve the students actively in model lessons based on computer use. It is not sufficient to *talk* about software and software applications; the principal/student must experience the computer as an integral part of the instructional environment and have ample opportunity to personally use a variety of software applications in preparing classroom materials.

Many principals surveyed are users of computing for administrative tasks in their schools. They recognize the value of the computer as a tool for their own work. The problem is that most of these administrators were classroom teachers before computer technology was widely available for use as an instructional tool. The use of computing as an instructional tool is not a part of their own teaching repertoire, and although they recognize the computer's value as a tool for administration, they continue to "teach," or lead their own teaching staff as they were taught by administrators when they were teachers.

These principals have accepted technology as a tool to improve their efforts in the work place; now they need to experience the computer as an instructional tool. Many teachers surveyed at the University of Hartford[1] claimed that, even when funding was available for computers, principals often divert these meager funds to improve the school's administrative computing capability.

Following is a brief outline of such a course that has been successfully tested with a wide range of administrators.

Week 1	Introduction: The computer as an instructional tool Research and practice Operating Systems
Week 2	Logo: What it is; what the research says Microworlds: Introduction to Logo Writing simple programs
Week 3	The Computer as Tool I Word processors, spelling and grammar checkers Desktop publishing
Week 4	Word processing and the writing process Controversy and research
Week 5	The Computer as Tool II Databases, creating form letters and reports
Week 6	The Computer as Tool III Spreadsheets, graphing software, "What if?" software Applications in math and science

Week 7	Logo and its use in Language Arts Create your own ending, collaborative writing
Week 8	Graphics tools Producing graphics (signs, certificates) for classroom use
Week 9	Teacher Utilities Test generators, gradebooks, electronic chalkboard
Week 10	Problem-solving software "The One-computer Classroom" The computer as stimulus for discussion Integration of Mathematics, Social Studies, Language Arts
Week 11	Cooperative Learning Simulation, problem solving, and writing projects
Week 12	CAI and Integrated Learning Systems Video of several systems (Jostens, Computer Curriculum Corporation, Curriculum Networking Specialists, Macmillan/McGraw-Hill) Student presentations and discussion
Week 13	Evaluating software Sources of evaluation, Evaluation forms
Week 14	Telecommunications: modems, various commercial products using telecommunications (e.g., Kids Net)

Each session of the course begins with a demonstration, modeling instruction with technology, or video tapes of children using technology in a school environment, and discussion of research. Time is allotted in every class for students to experiment with various software products to produce classroom materials. This course has been successful in part because it forces administrators to again become students. Each participant must be actively involved in preparing material, evaluating software, and role playing a student being taught Logo or participating in a cooperative effort to complete a simulation. During lab exercises, students are required to work in pairs or groups of three. This arrangement permits the novice users of educational applications to "spread the blame" for lack of success and to "share the fame" for successful mastery of software packages.

The Principal as Leader

A survey conducted by California's Computer-Using Educators group (Marshall, 1992) concerning how principals can help support and enrich the use of technology of in California schools revealed that teachers want principals to know about classroom uses of computing. Teachers said that principals can best provide assistance, support, and leadership by:

- using technology to find out how useful it is,
- becoming more knowledgeable about technology, especially to assess the best approach for students,
- being an instructional leader,
- learning right along with staff, and
- asking help from people who know about the benefits of technology.

During the past two years we have been conducting ongoing surveys with the students in the Graduate School of Education at the University of Hartford. We are investigating the extent to which computing is actually being used as a part of the instructional program in local schools, asking teachers about the role of their school administrators in the introduction and support of computing and technology in the curriculum. Most teachers surveyed believe that the principal plays a pivotal role in the introduction of technology to schools. Common among the suggestions offered by these teachers was an urging for principals to get personally involved, to try out technology, to roll up their sleeves and learn along with the rest of the staff. Teachers believe that principals should visit classrooms where technology is being used for instruction. The single most often offered suggestion, however, was for more leadership from the top - the "roll up your sleeves and sit down at the computer with the rest of the staff" type of leadership. It is interesting to note that less than 40% of the teachers surveyed considered that their administrators were showing active leadership in bringing technology into the classroom.

The survey also showed that teachers would like principals to:

- help provide more funding, especially by monitoring sources of funding outside the school and district,
- take advantage of the resources available and don't be afraid to move forward,
- set aside part of the budget to help the school attain technology in all classrooms and the media center,
- let teachers try out new ideas and uses for technology in a risk-free environment, and
- help teachers with limited exposure to computers to acquire more skills.

A Final Word

The need for educational change is pressing. It is an issue that has been central to the major political campaigns of the late 1980s and 1990s. The Edison Project, the new alternative schooling initiative being spearheaded by Christopher Whittle has recognized that technology can play a positive role. But, schools of education have an incomplete focus. All too often, the courses that espouse innovative educational practice are geared to *teachers only*. Graduate programs for school administrators generally have little focus on the*specifics* of educational innovation, rather they take the more general view of educational change. It appears that there is an assumption that information about specific instructional innovation will "filter up" from the teachers to the principals -- or that principals, having once been teachers themselves, received their grounding in instructional practice at that time.

Technology as an integral part of the instructional program is relatively new. We cannot assume that principals have first-hand experience using technology in the classroom, or that technology training was a part of their teacher training. If we believe that technology should be a part of the teaching-learning environment, we cannot afford to take the chance that this "filtering up" from new teachers will happen. If the principal's most important role is that of instructional leader, that of change agent, then the principal *must* be involved with the newest educational movements. This must become an integral part of the school administrators' program, both as course content as suggested in this paper and as part of the repertoire of all graduate school professors.

Endnote

[1] Surveys conducted in Graduate classes in the College of Education, Nursing and the Health Professions. Paper in preparation.

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A learning organization on Long Island: Technology in teacher education as it relates to a fourth grade project and Peter Senge's work on learning organizations

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A Learning Community, Not a Cluster of Boxes

Imagine a learning community comprised of open and connected learning systems. Components would include, for example, from pre-school to post doctoral education, and lifelong personal and professional pursuits. Such a philosophical shift of mind opens to the thinker a new way to visualize what education is and what it can do as it evolves within a community. Educational goals may be multiple and complex and may include a community of lifelong learners and lifelong contributors to the community. Within this conceptual framework, schools and classrooms, teachers and learners, may change.

This notion of community is part of a shared vision which is emerging from people who are beginning to think globally and to define what they truly desire for education today. Rather than see box-like images of colleges or universities, school districts, school buildings, classrooms, departments, each with walls andboundaries, members of this community see those pieces as open links to a larger system. Traditional barriers are fading more quickly than participants had imagined.

Peter Senge (1990), in *The Fifth Discipline*, presents philosophical, theoretical, and practical reasons for creating learning organizations rather than the customary businesses, governing bodies, or associations now in existence. His ideas encourage the reader to think in systems and structures, to build shared visions with others which, over time, allow a team of people, to learn and grow together and reach toward goals which they jointly define.

> The tools and ideas presented . . . are for destroying the illusion that the world is created of separate, unrelated forces. When we give up this illusion - we can then build "learning organizations," organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together. (p. 3)

The shared vision is intended to be ever-growing and maturing as it becomes clearer and better attuned to the society in which it exists. As the vision grows, steps are made toward creating a reality which would move it toward its goals. The "vision-reality gap," the distance between the two, needs "creative tension" to energize an organization as it moves the reality in the direction of the vision.

As educators and others articulate the need for restructuring and redefinition of education today, it may be refreshing to add a dimension which may propel education toward becoming a community of learners. This work presents a venture which conceptualizes Long Island, New York, as a learning community. It then focuses on a technology and teacher education program on the college level which is itself evolving into a learning community integral to the larger Long Island community. A further discussion of Senge's work follows with reference again to the relationship between the reality and the ever-evolving shared vision.

The Long Island Team Project

A Learning Community Project

A group of educators and other community members met to collaborate on a vision of education,infused with technology, which would "break the mold" of schools as we know them today and create a learning community for tomorrow. That group wrote the following statement in February 1992 (The Long Island Team, 1992):

> The Long Island Design Team plans to establish a Long Island coalition of community-based, widely varied learning centers, operating 24 hours per day, 365 days per year, linked by a technological highway connecting all community members, regardless of age, location, background, and ability. The purpose of these centers is to instill and then sustain within students a desire to learn and be productive. The model should result in life-long learners who make maximum use of all resources. (p. 1)

The group then met regularly to continue the development of their vision and to plan for a first phase project which would envision Long Island as a living, learning community. As technology would be a powerful tool envisioned in the system of tomorrow, technology would be used by all who participated. Inaddition to the use of computers, video, and other technologies, all participants would be linked via telecommunications to share ideas and collaborate. The content area chosen was Long Island history, a subject studied in fourth grade classrooms across Long Island and potentially linked to other disciplines (e.g., language arts, science, mathematics, the arts). That topic was thought to be an ideal vehicle to begin the process of envisioning Long Island as a community, a place to contributed to, live and work in, study, share, and celebrate. Fourth grade teachers and students, as part of a larger learning community, would reach out potentially to all others. It would be a learning experience developed beyond the box of the classroom with teachers and learners thriving in a vital system.

Very quickly districts who heard about the project asked to participate. Ten districts spanning more than 100 miles across Long Island joined in. Each was asked to select two teachers. Some selected as many as five. Higher Education came in with administrators, faculty, graduate and undergraduate students. Educational Technology masters' students brought in their own fourth grade classes from additional school districts. BOCES (Boards of Cooperative Educational Services in New York), community members from such areas as historicalsocieties, libraries, the media, businesses and industries, joined in and contributed their resources. Parents, siblings, neighbors, and others in the community asked to join. The details of the project(s) are now being created as activities have begun and ideas are being shared over the telecommunications system. A culminating event in May 1993 will bring together the more than 1,200 students involved with all other participants (at the moment more than 200 of them) to meet face-to-face and share themselves, their ideas, their efforts, and their products.

Goals

Beyond the most global goal of producing an ever-strengthening community of lifelong learners, are critical elements being defined. Three of these will be discussed: a) the identification of and involvement of outstanding teachers and other leaders in the community who are placed in positions to grow professionally and become models for others in the system, b) the importance of dedication and commitment to the creation of the vision, and c) the development of systems for communications between all interested members of a community for learning, sharing, and collaborating. These elements are consciously built into the model. Jointly they should contribute to the evolution of the system as nurturing, powerful, anddynamic.

Outstanding Teacher/Learners

Outstanding members of the education and larger community are being identified and offered an opportunity to collaborate, envision, create, develop, and then accomplish goals which they set for themselves and other learners. Participants are using technology whether they have a background in it or not. Teachers are given computers and modems by their school districts for use in class and many are given comparable loaners for use at home. Technology training and support are offered from a variety of sources. They come primarily in the form of assistance for active work on the project rather than as a tack-on new skills to master. It is expected that the participants from this year's projects will become leaders (mentors, advisors, collaborators) in projects in future years. The system should then continue to build with outstanding educators growing and learning themselves as they link their students to continually expanding learning communities.

Dedication and Commitment

Another critical element is the energy whicharises from a group of dedicated and committed individuals who feel that they together can define andthen make a difference in society. The project itself is not an extracurricular activity but rather built from its participants' redefinition of how they use their time, effort, and energy to accomplish their goals. This is a project without a grant or major single funding source. All participants "give" although there is no set amount of time, effort, or energy required. It seems to be that freedom which is producing a deep and sustaining dedication and commitment. A corollary is that interest by people who seem only to "want" (e.g., funds, training, hardware, software) has dissipated. Such individuals do not fit in. They know it immediately. They either become "givers" and part of the team to define the vision, or they "get" out. The community, therefore, is propelled and energized by people who believe in the strength of the union of forces joined through the project. They all have ownership in the project as they have made the rules and created the vision. Initial observations show these individuals to be creative, energetic, and productive.

Communications for Sharing and Collaboration

The sharing of ideas, projects, and products is facilitated by a combination of technological tools and face-to-face events. *Newsday*, a Long Island newspaper, has provided a telecommunication backbone. All participants are encouraged to log on and read and respond to others on a Long Island Team forum. E-mail is also provided for individual contact. For some participants, this is their first taste of the power of computer resources which they have not yet mastered. Activity on the system is increasing exponentially day by day.

Two kick-off sessions were offered before the opening of the school year. One was an informal gathering at the home of a participant. The other was a brainstorming and planning session facilitated by the use of *TeamFocus*, a strategy and planning software, provided to the group by IBM. Pairs of individuals who had never met before inputted responses into computers and responded to others' ideas on the screen. Small group strategy sessions followed and resulted in clusters of individuals exploring ideas together. Output from the sessions were used to spark creative ideas for the year. Additional events are being announced over the telecommunications forum and are periodically held across Long Island.

Technology and Teacher Education

A Learning System, A Learning Community

In addition to the activity being generated across Long Island, the activity in the Educational Technology Department at Long Island University is philosophically blended into the larger learning community. Instead of separate undergraduate and graduate classes using technology in teacher education, the members of the department have been moving toward greater collaborations and team structures within and beyond the university for the past several years. The Long Island Team project has provided a new venue for this evolution and an opportunity to grow within its greater vision. All classes are now linked in some way to the project. Students are given the opportunity to connect to it if they wish. A few faculty from other departments are joining in. Hundreds of stories could be told already of collaborative projects which have begun the process of "learning community." Faculty and students serve as both teachers and learners. To follow are a few examples.

A required undergraduate course, *Computers in Education*, and an advanced undergraduate course, *Making Connections Beyond the Classroom Walls*, have been transformed into a learning system. Seven sections of the required course and one section of the honors course are being led by a team of faculty who first teach five weeks of basic skills and then devise with their students cooperative group projects linked to the "real" learning projects in the Long Island Team fourthgrade history project. The teaching team meets weekly with one another but communicates more often via telecommunications. Graduate assistants operate a computer laboratory full time for additional support, guidance, and involvement. They, too, meet with the teaching team and students and are active members of the learning community. All students are linked to one another, all educational technology faculty and staff, all educational technology graduate students, and all Long Island Team participants via telecommunications and through their various projects.

One undergraduate section, for example, has prepared a database of the Long Island history of its students which it now is incorporating into a *LinkWay*, multimedia program as a learning and teaching tool. The database itself is being expanded in another section which is studying databases. The ideas behind the evolution of the *LinkWay* project were shared by the teacher and students over the Long Island Team electronic forum one evening. Within an hour, one of the fourth grade teacher participants responded enthusiastically to the ideas presented, and said that she would like to expand her classroom *HyperCard* project for the Long Island Team to include similar materials to the college student project. Could they collaborate?

In another case, it is expected that there will be a thread of activities which will celebrate multicultural diversity at the Long Island Team May 1993 culminating event. This thread will begin as a topic on the electronic forum. Interested participants will then define it further throughout the year. During the Fall 1992 semester, two undergraduate students are learning and using *PageMaker* to create a print document about multiculturism. They are interviewing experts in the field, and sharing ideas, scholarly books and articles, database literature searches, and possible projects ideas with the participants across Long Island.

On the graduate level, courses in telecommunications, desktop publishing, computer graphics, research, television and video, and several master's theses are being linked to the undergraduate "learning system" and the greater Long Island Team. Some people are managing the telecommunications forum. Some are creating documents. Some are doing research. Others are going into the schools to work with the teachers and students using a broad variety of tools and technologies. They are bringing some of the undergraduate with them. Faculty are participating as teachers/learners along with all others. Alumni and community volunteers are joining in. One faculty member recently asked how the others are grading the university students this semester. Will they useportfolio assessments and with what criteria? Old teaching and grading systems do not seem appropriate in this setting. Students are using the technologies and learning them for "real purposes" and "real audiences." Most are defining their own work and attentive to the quality of their learning processes and their products. Faculty are beginning to reassess their own teaching styles, delivery systems, goals and objectives.

The Long Island Learning Community and Senge

Individuals are growing within the "whole" of Long Island and moving toward a vision, a learning community. Senge presents five disciplines critical to a successful learning organization: Personal Mastery, Mental Models, Shared Vision, Team Learning, and Systems Thinking. "Each provides a vital dimension in building organizations that can truly 'learn,' that can continually enhance their capacity to realize their highest aspirations" (p. 6). Not all, but many members of the Long Island Learning Community are consciously working through Senge's five disciplines as they participate in the creation of a learning organization. A glance at the five areas should highlight their relevance to the Long Island Team endeavor.

Personal Mastery

Personal Mastery builds from an individual's commitment and capacity to learn. It is the individual's contribution to the whole which digs deep into his or her soul to maximize personal growth, while participating in the further creation of and progress toward the shared vision. Senge speaks of "continually clarifying and deepening . . . personal vision, of focusing . . . energies, of developing patience, and of seeing reality objectively" (p. 7). Long Island Team participants are encouraged to develop professionally and personally and permit that growth to impact upon others and upon the whole. Risk taking, reaching out, seeing something beyond one's own experiences and wanting to grow within it are pieces.

Mental Models

Mental Models develop from one's ability to see beyond wherever one is, to create mental pictures of where one can go, and to develop strategies to take one there. For the Long Island Team members it is the shift from seeing themselves within their "boxes" (e.g., schools, classrooms, or departments) to the vast freedoms within an open learning community. They collaboratively create the vision and then seek the doors and hidden doors which when opened allow movement toward the vision. Mental pictures which block such as those associated with "but there are budget cuts" or"but there is no time or space for additional activities" create barriers and boundaries. The Long Island Team is working without such confining pictures and is finding few limiting factors.

Building Shared Vision

A shared vision evolves as participants move closer to one another and the definition of their common purpose, goal, and spirit. Beyond the particular details of the fourth grade Long Island history projects, participants are beginning to see ideas and resources which can be shared as the whole can better drive itself toward the vision. That vision is continually being acknowledged, refined, and developed. Individual growth and collaborative growth are moving it with force.

Team Learning

Senge believes that teams are the basic learning unit of modern organizations. Teams can learn more and learn better as individuals and collaborative groups learn to use effective tools and strategies while working toward their goals. In the Long Island Team Project, participants are not isolated but are learning individually and from one another. Individual skill development, such as learning to use technologies, in addition to the growth of projects,programs, ideas, and philosophies, are seen as supported by all of the others who are sharing the experience. On the telecommunications forum, members are questioning, asking, answering, responding, and growing together.

Systems Thinking

Senge's fifth discipline is systems thinking. It is the integration of the other four disciplines into a whole which blends theory and practice, individual growth and personal mastery with team learning and mental models. Through these four disciplines the "whole" moves toward the creation and realization of a shared vision. For the Long Island Team members, the philosophy and the practical movement toward the vision, are growing together. The mental images of the Long Island Team system which have been described are far more than interesting projects in which fourth graders and community members study Long Island. They are also more than the development of vision, goals, and objectives. Rather, these are the elements which, along with other elements, can be seen as the blending of dynamic forces weaving themselves into a complex learning community.

A Long Island Learning Community Has Begun

To envision this system, one must see interrelationships, rather than linear progressions. The strength, creativity, and vitality of the processes have become their own forces. Not all aspects of the fourth grade project are smooth and flawless. Senge suggests that some things take a long time to harvest. They require seeding, continual nurturing, evolution, and movement toward whatever it is that really matters. Although the tangible outcomes of the Long Island Team community will be analyzed and evaluated at the close of the school year, the goals of its members have already been realized. People joined this community to participate in the process and to grow and learn within it. Preliminary data from participants suggest that many have been swept into a process from which they hope never to retreat.

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Integrating technology into a teacher certification Master's Degree program

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History of Computers in Education at Lesley College

Lesley College, Graduate School of Education, started a master's degree program in Computers in Education in 1979. The program quickly became a national leader primarily because of its timeliness. Many other universities adopted parts or the whole of the program. The program experienced exponential growth on-campus from its beginnings to about 1988, while the off-campus program is still growing.

Education faculty from a variety of discipline areas—reading, social studies, mathematics, and science—developed the program. None of the faculty had technical backgrounds. All had early exposure to desktop computers and became excited by the possible applications to K through 12 education. Since 1981, the degree has been offered in cities across the country. Approximately 5,000 teachers have received master's degrees from this program, while many more have taken courses. The degree is currently offered in 24 locations.

The faculty's philosophy is to focus on technology as it can make a difference in teaching. Tool use, looking at ways to put the child in control of his or her learning, and setting up classrooms where students and teachers work collaboratively on problem solving, are stressed.

Technology Goals

The computers in education faculty have both long term and short term goals. In the short term, the faculty hopes to keep the degree program current, dropping requirements that no longer serve teachers and continuously creating courses that apply emerging technologies. Examples of dropped requirements include most of the programming language courses, courses focusing on software evaluation and on computer aided instruction. Some of the newer courses include such topics as integrating multimedia into the curriculum, educational applications of HyperCard, and video as an educational technology.

In the long term, the computers in education faculty envision the eventual phasing out of the maser's degree program. Such a narrowly focused program should no longer be needed when technology is integrated, as appropriate, into all the teacher education courses. The faculty recognizes that there will always be a need for a core group to keep well informed in the area of technology and create courses focusing on new developments. However, the degree as such should be eliminated.

To implement this goal, in the early 1980s, the computer faculty began to train the rest of the education faculty to use computers for their personal needs, such as for word processing, desktop publishing, and statistical analysis. The computer faculty was able to provide, through its grants and contracts, adequate technology for all the education faculty and staff. Computers were even "checked out" by faculty for home projects.

Once the faculty had embraced the use of computers, we assumed technology would infiltrate their teaching. We were wrong. In 1990, to remedy the situation, the computer faculty decided to attack the problem directly by focusing on the preservice program first. This paper attempts to document these efforts and to try to understand the continuous frustrations we have encountered.

Results of Goal Implementation

The short term goals are easy to implement. The computers in education faculty are the "believers" and want to maintain the program's leadership. As a national program, it is not difficult to keep abreast of the needs of teachers around the country. Being located in Cambridge, MA, it is not difficult to keep abreast of the latest developments in technology. What has been difficult and frustrating is attempting to implement the longer term goals. Reported here are the authors' understandings as gleaned from talking with the faculty who teach required preservice courses.

In the programs as they are now stated, no explicit technology requirements are included for the early childhood certificate. For the elementary certificate, technology is a part of the course, *Methods and Materials of Science, Social Studies and Health*. The title alone suggests the overwhelming nature of the course. In the middle school certificate the course, *Computer Literacy for Educators* is required. Technology courses are offered as electives in the special education certificate programs. Lesley does not offer secondary certificates.

The faculty comments about their involvement in technology fall into nine categories, represented by:

1. I never thought about the issue of technology.
2. Our students don't see computers or other technologies in their practicums so why should they learn about them in their courses.
3. 98% of the people working with 4 and 5 year olds are against using computers with early childhood students.
4. Our students do not need to learn about technology here because they will learn once they are out teaching.
5. I have always had trouble getting the software and hardware I need to the class in which I am teaching.
6. I did more in the early years, but software was not that good so I dropped back and now I just talk about where technology might help elementary students with writing and spelling.
7. In the area of special education, I found it very hard to keep up with the technology so I dropped it out of my courses.
8. I show lots of software in class but do not require students to do anything with it out of class.
9. Technology is totally integrated into all my courses. I can't imagine thinking about teaching without technology.

What emerges from these interviews is a continuum relating to the integration of technology in the preservice courses going from, "it is not a subject I ever thought about", to, "I can't image teaching without technology." Unfortunately for our students, the integrated technology end is only representative of one faculty member teaching one section of a four section course.

Understanding the Issues

Larry Cuban suggests one way of looking at the problem when he observes a "linkage between the unharnessed growth of a specialization within all levels of schooling and the absence of community among educators engaged in teaching." (1992b, p. 8) In spite of the fact that the computers in education faculty made every effort to expose the education faculty to all forms of technology that might benefit their professional work and their teaching for the last ten years, the education faculty does not yet think about technology as having a bearing on their specialization. The three people expressing the most technology aware comments are either currently or were at one time computer faculty. The reasons for the lack of technology being integrated into the mainstream of the school of education courses are complex. Many of these reasons have been revealed to us through our years of effort at Lesley and are now confirmed by these interviews. They include:

- Lack of enough technology in the schools for it to "make a difference",
- Lack of adequate teacher education to have role models for student teachers,
- High degree of specialization among college faculty,
- Faculty's ability to separate their personal and professional lives from their course content and teaching strategies,
- Speed of technological developments and increased energy required to "keep up",
- Unwillingness of faculty (or probably most people) to face messy problems,
- Lack of a clear, generally accepted, vision for the role of technology in education.

Technology in the Schools

The faculty interviewed gave mixed reports as to the amounts of technology they see in the schools or their students talk about in class. Faculty report seeing at most one computer per class plus a computer laboratory per school. Several faculty mentioned noticing much less in the inner city schools. One practicum supervisor, who has been supervising student teachers for ten years, said she never observed a lesson where her student teacher used a computer.

The literature seems to back up the perceptions of these faculty. Holden notes that, "although there are now an estimated 1.5 million computers in the public schools—one for every 30 kids—nowhere can they be said to have transformed education." (p. 906) Today's estimate is about 1 per 18 students. Cuban suggests that even though there has been a dramatic rise in the number of computers in schools, "for those individual students who use computers (and not all do), the time they spend doing it is, on average, a little more than one hour a week (or 4 percent of all instructional time)...The overall picture after the introduction of the personal computer a decade ago can be summed up in a one-line caption: Computers meet classroom; classroom wins." (1992a, p. 36)

Teacher Education

Teacher education has been a major identified need since computers first appeared in schools. Shao say, "Only a third of all public school teachers have even 10 hours of computer training—and the time is mostly spent learning to use the machine, rather than how to teach with it...But in general, little is being done to remedy the training gap—by the education colleges, school systems, or the companies that sell into this market" (p. 110) It became clear to the computer faculty in the early years, that it takes about 1,000 hours to create technology comfortable teachers who are able to begin thinking about integration issues. Once this 1,000 hours is invested, it is then necessary for teachers to commit, in addition to their usual professional development time, many hours keeping up with technology change . The whole scenario can quickly become discouraging for people teaching at any level, especially those hoping finally to reap the rewards of hard work early in their careers.

Faculty Specialization

Cuban introduces the problem of specialties from a slightly different perspective, but it is nevertheless the same problem being encountered at Lesley. "The notion that professors and practitioners are engaged in the same enterprise, sharing common purposes, has been shredded into finely chopped specialties, distracting dichotomies such as theory and practice, and an abiding hunger for higher status by increasing the distance of scholars from public school classrooms." (1992b, p. 8) Lesley actually cannot be faulted for separating theory and practice. Its faculty is very much classroom based. However, when it comes to seeing a common purpose in the teaching of reading, or science, or mathematics, or looking at the role of technology, each faculty's specialty is the most important and therefore should take up most, if not all the student's attention while in graduate school. Working together to help our students understand the problems of schools today and collaboratively seeking solutions, even if it means giving up a required course in a particular specialty; or reworking the overall concept of what is necessary today to be an effective teacher, has not yet taken hold here.

Separation of Personal and Professional Life

Until very recently, the computer faculty was not aware of this phenomenon. Watching the dramatic increase in use of technology in faculty offices, seeing faculty borrow computers and eventually buy them for their homes, we just assumed the courses these people taught also were being affected. It wasn't until we began meeting regularly with the staff in the Computer Center that we realized the very few faculty requesting machines or technology support for courses. For the past three years the administration has set aside money for faculty development in the area of technology. The faculty Academic Technology Committee can fund whatever it wishes based on the proposals it receives. It has been a struggle to award the money each year, since we determined form the first to focus on helping faculty integrate technology into their curriculum. Faculty seem to clearly separate their personal lives from their teaching. They talk about their own children and grandchildren using technology, they express interest in having newer machines and more software for their offices, but do not seem to make a linkage to their own teaching.

Speed of Technological Developments

Problems of coping with change have existed since recorded history. Heraclitus, in 501 B. C., said, "There is nothing permanent except change." There is an old Chinese proverb, "When we talk of tomorrow the gods laugh," while the Queen told Alice in *Through the Looking Glass*, "To stay where you are, you must run as fast as you can. To go anywhere else, you must run faster yet." People have always used change as an excuse for procrastinating. It seems the excuse is used more today, but it might just seem that way!

Messy Problems

"The common observation that Americans seek a cure for every disease, a tidy ending for every film, and a beautiful sunset after a troubled day has become a cliché. This culture prizes getting the job done, speedy and efficient technology, and asking the basic question, Will it work? Acknowledging that many situations are unsolvable and require good-enough trade-offs goes against the cultural grain and creates guilt over failing to remedy problems."

In a can-do culture, a pervasive sense of guilt often haunts practitioners, professors, and policymakers who face recurring, insoluble situations and repeatedly fail to 'solve' the 'problem.'" (Cuban, 1992b, pp. 7-8) Our education system does not give us strategies for dealing with real problems and unsure solutions. This is one of the prime areas the American Association for the Advancement of Science (AAAS) and the National Council of Teachers in Mathematics (NCTM) has targeted in their work over the last 10 years. It is perhaps understandable why faculty who themselves have come through "traditional" schools do not cope well with *messy problems*. Integrating technology into education is certainly a messy problem. "The fact is, after more than two decades of research, the task of successfully integrating computer technology into regular instruction still appears daunting." (Holden, p. 906)

A Clear Vision

NCTM has created a clear vision about the changes needed in the precollege mathematics curriculum. The organization's members have spend untold energy over the last few years since the *Curriculum and Evaluation Standards for School Mathematics* was published to get the teachers across the country to accept this vision. In the area of technology, however, "after a decade of enthusiasm, there's still no clear consensus about the role, value, or effectiveness of computers in schools. Well-thought-out goals are still lacking." (Shao, p. 108) Another explanation for this problem is offered by Marcia Linn at the University of California at Berkeley who feels, "there has been a 'backlash' in some places following misguided enthusiasm in the early 1980s when many school districts eagerly piled up computers from whatever sources they could muster...Although teachers are generally said to be interested in technology, many have been burned by having computers 'dumped in their lap.'" (Holden, p. 907) Similar phenomena are noted by education faculty interviewed. Comments such as, "In the early years I made an effort to integrate technology into my course, but over the years I could not keep up with the changing technology," suggest somewhat of a backlash at the higher education level as well.

Working toward a Better Situation

Given the discussion above, let us assume there is no clear cut solution for the problems outlined. There might, however, be guidelines for working toward a better situation. There is general agreement that technology is having an impact on our world. The agricultural revolution took 5,000 years, the industrial revolution 300, the information revolution 15. A first positive note is that most people recognize this situation, even education faculty. Cuban suggests one way to change how we think about such dilemmas are "to get unstuck from familiar 'solutions' and create better compromises and more elegant tightrope walks." (1992b, p. 8) The interviews done at Lesley for this paper raised awareness of the problem and started a conversation that is long overdue. Perhaps these are the first steps to getting unstuck.

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Infusing technology in the curriculum: Training school media specialists

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Introduction

Eastern Washington University offers an initial level endorsement in school library media that enables a teacher to administer a school media center and/or instructional materials center. Other teacher candidates choose this option to enhance their knowledge of instructional materials and technology. This endorsement program was reviewed to incorporate foundation standards in educational computing as developed by the International Society for Technology in Education (ISTE, 1992). Rather than develop a separate course about computers for media centers, computer components were infused throughout the endorsement curriculum.

Roles of School Media Specialists

Four roles of the School Media Specialist have been delineated (AASL & AECT, 1988). These include teacher, manager, information specialist, and instructional consultant. The SMS is an active teacher of ideas and manager of resources, in addition to being a specialist in the area of information sources, formats, and delivery systems, which are increasingly being digitized. Further, the professional SMS is an instructional consultant who demonstrates leadership incorporating computer-based technologies throughout the curriculum. While teacher candidates may not feel qualified to teach with technology (OTA, 1988), it is essential that the SMS have this confidence. Certification programs across the country are increasingly including competencies with technology (Pettitt, 1992). With technologies geometrically providing information formats, the SMS is often the first in the building to teach students and fellow teachers to learn to use computer-based technology resources, when searching for information.

Configuration Model

From the Concerns-Based Adoption Model, the concept of innovation configurations was adapted (Hall, G. E. & Hord, S. M.,1987; Hall, G. E. & Loucks, S. F., 1978). An innovation configuration identifies essential components indicating the presence of using an innovation. A configuration model was created to develop an integrated program of study for the general undergraduate teacher preparation program in order to integrate technologies with course content (ISTE, 1992; Todd, 1992). Three indicators were selected to provide a process model for incorporating a variety of computer based technologies and activities: a course content objective, computer practice, and ISTE guideline. Because the SMS is expected to be a leader in technology uses, it is important that technology knowledge and skills also be carefully incorporated within the endorsement program.

Content objectives. An essential assumption is that computers should be used to facilitate content learning.

That is, before selecting delivery systems, content should be identified. Only then should the content be matched with a computer-based technology (Berger & Carlson, 1988). Therefore, the first step was to identify existing course content that could be facilitated with a computer-based technology. This was done by considering possible activities and potential software programs that could facilitate learning. A minimum of two content objectives were identified; however, for several courses, more were selected. By having candidates participate in computer activities, they are also being provided by faculty with models of teaching with technology.

Computer practices. After listing the variety of activities that would be used to facilitate content objectives, all of the practices that might reasonably be included were listed. As a working database, the practices framework developed by Sheingold and Hadley (1992) was used for reference to ensure that a variety of practices would be included. There are eight major categories that include thirty-six types of tools. These include: Text processing (keyboarding, outlining, spell-checking and thesauri, and word processing), instructional software (drill and practice, software accompanying textbooks, problem solving, and tutorials), analytic tools (calculators, charts and graphs, databases, laboratory interfaces, spreadsheets, and statistical programs), programming and operating systems (authoring, BASIC, Fortran, Hypertalk, LOGO, operating systems, and Pascal), games and simulations (instructional games, microworlds, and simulations and recreational programs), graphics (computer-aided design and drafting, desktop publishing, drawing and painting, music, and ready-made art), communications (commercial mail, on-line databases, on-line services, public bulletin boards, school-to-home communications, and school-to-school communications) and multimedia (robotics and videodiscs). Not all of these were selected to be included; just those most relevant to services provided by a SMS. These were again reviewed and selections of content objectives and practices were then made, so that a variety of practices would be represented.

ISTE guidelines. The last step was to match the activities and practices with appropriate guidelines developed by The International Society for Technology in Education. This group developed a list of thirteen computer competencies that all teachers should acquire. These foundation standards have been approved by the National Committee for Accreditation of Teacher Education [NCATE] as accreditation standards for teacher certification programs. These programs will need to ensure that all candidates meet those foundation standards. Table 1 summarizes the content of each of the thirteen competencies.

Table 1
ISTE Foundation Guidelines, 1992

1. Operating computer system and utilizing software.
2. Evaluating and using computer-based technologies for instruction.
3. Applying research-based principles of instruction and assessment to using computers.
4. Evaluating and using computer-based applications, documentation, and materials.
5. Using computers for collecting data, communicating, making decisions, managing information, preparing presentations, and solving problems.
6. Preparing computer-based activities for divergent student populations and grouping.
7. Being knowledgeable about software applications for one's discipline and teaching levels.
8. Being knowledgeable about instructional uses of hypermedia, multimedia, and telecommunications.
9. Using teacher utilities including databases, graphics, spreadsheets, and word processing.
10. Demonstrating and modeling understanding of social issues, including equity, ethics, and legal applications of using computers.
11. Identifying resources that provide information about computer-based technologies.
12. Using computer-based technologies for information access.
13. Using computer-based technologies to support changing roles of teaching and learning.

Because the SMS is expected to be a leader in technology uses, it is important that technology knowledge and skills also be carefully extended within the endorsement program. Again, these were reviewed to ensure that all thirteen guidelines were addressed as course content was approached with computer activities. A minimum of two guidelines per course were identified. Faculty are not limited to addressing only those particular guidelines, but are encouraged to use computer-based technologies wherever appropriate to facilitate content learning.

Endorsement Knowledge Base

Certification requirements for an endorsement in learning resources in Washington state include six essential areas of study: Selection of learning resources, reference and information services, children's and young adult literature, organization of materials, management of learning resources, and production of learning resources.

Table 2 displays a summary of the number of course content objectives that were selected, computer-based technology practices, types of computer tools to reach the objectives, and the ISTE guidelines that will be fulfilled by the activities. A careful examination of the curriculum indicates that each of the courses incorporate several ISTE guidelines.

Since computer-based technologies cut across all areas of this field, a pre-requisite for entering the endorsement program is a course in Computers for Teachers offered by the Computer Science Department. The course provides basic instruction in word processing, databases, spread sheets, graphics, and telecommunications. In this way, students have a rudimentary introductory knowledge of operating computers and utility programs. This course meets ISTE guideline number one, to be familiar with computer system operation and software utilization, and guideline number nine, to be able to use a variety of teacher utilities. Endorsement candidates are required to purchase Microsoft *Works*™ in either Macintosh or DOS format and to prepare all papers with word processing. They also must use the electronic databases and card catalog in the university libraries to access information for reports and papers.

Selection of Learning Resources. Students evaluate and select and resources in a variety of formats that include computer programs and laserdisc products. Students use CD-ROM databases to access information about learning resources, as well as apply selection criteria for software and hardware appropriate to school library media centers. Students are introduced to on-line

Table 2
Curriculum Matrix

	Number of Content Objectives	Practices	Types of Tools	ISTE Guidelines
Selection of Learning Resources	4	Text processing Analytic tools Communications Multimedia Instructional Games & Simulations	Word processing Databases On-line services CD-ROM	4, 7, 8, 9, 12
Information and Reference Services	4	Text processing Analytic tools Communications Multimedia Instructional	Word processing Databases On-line databases CD-ROM/laserdiscs	2, 3, 6, 7, 9, 12, 13
Children's and Young Adult Literature	3	Text processing Instructional Games & simulations	Word processing	4, 6, 9
Organization of Materials	6	Analytic tools	Statistical On-line services Databases	5, 9
Management of Learning Resources	2	Text processing Analytic tools	Word processing Spreadsheets	5, 9, 10, 12
Production of Learning Resources	4	Programming Multimedia Graphics	Authoring systems Videodisc Ready-made art Drawing/painting Desktop publishing	1, 4, 8, 9, 13

databases for materials selection since the SMS can access on-line sources and create purchase requests via telecommunications. Students also volunteer for ten hours in a school library media center evaluating the collection and recommending additional resources in many formats.

Information and Reference Services. Students learn about a variety of information sources and instructional methods for incorporating those sources in lessons including using instructional software for information seeking. Students learn to teach on-line searching skills that incorporate laserdisc reference products that support the curriculum. Students also spend ten hours in a school library media center developing instructional strategies and teaching that include electronic information sources.

Children's and Young Adult Literature. This course provides an opportunity for students to examine computer-based technologies that support literature appreciation. Students have an opportunity for hands-on evaluation of instructional software, including CD-ROM and videodisc products and, which can be used for literature enrichment.

Organization of Materials. In this course, students learn to use and evaluate computerized circulation systems. They learn to use these systems to generate circulation reports incorporating statistics. They also use computers to process materials and learn to adapt machine readable database records for classifying and cataloging resources. These records can be acquired in CD-ROM formats or through on-line services. Students also spend ten hours in a school library media center processing and organizing materials. Only two of the ISTE guidelines are specifically addressed in this course; however, this class is the most technology-infused of the sequence because computers are used in each session.

Production of Learning Resources. The purpose of this course is to practice methods of developing materials. Students adapt materials and prepare original works. Students will use hypermedia and authoring systems to create original materials or edit videodisc products. They also can use paint programs and desktop publishing to prepare hand-outs and overhead transparency masters.

Management of Learning Resources. This course focuses on administrative tasks including policies and procedures for managing resources, facilities, personnel, and budgets. Students in this course use spread sheet programs to develop and analyze simulated budgets.

A capstone experience is a practicum of 90 hours in a school library media center taken in conjunction with the management class. Criteria for placement include the presence of computer resources. Approved practicum media centers must have a computerized circulation system and electronic databases. Participants engage in the full range of SMS responsibilities including collaborating with classroom teachers to incorporate technology information sources in lessons.

Summary

The configuration model provides a structure to review a curriculum that coordinates technology uses across a program. Faculty can monitor and adjust classroom experiences to ensure that students have a wide variety of experiences with many different technologies. It also helps to yield information that is useful for planning technology acquisitions.

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Integrating technology into graduate teacher education

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As technology becomes more accessible to teachers and students across the nation, teacher education programs have both the opportunity and the obligation to provide potential professional educators with access to innovative applications of educational technology. Recent articles and studies have called for a closer connection between teacher preparation in the use of technology and the application of technology into k-12 classrooms (White, 1991; Brooks and Koop, 1989). In many cases, school leaders often find that new teachers need as much training and experience with educational technology as do veteran faculty members of traditional school systems (Teachers and Technology, 1991). Several authors (Niess 1991, Bitter and Yohe 1989, Bruder 1989) have called for major revisions in teacher education programs so that beginning teachers will be prepared to develop and teach with an understanding of and a desire to use new educational technology. Unfortunately, colleges of education too often lag behind the rest of the campus in access to and incorporation of technology (Power On! New Tools for Teaching and Learning, 1988). Northeast Missouri State University and the Division of Education have taken an active position to meet the challenge of providing training in and access to educational technology for beginning teacher educators.

Between 1987 and 1993, Northeast Missouri State University (NMSU) has invested over $1.4 million in academic, library, research computing and technology facilities. Eight divisional and eight residence hall computing labs located throughout the campus provide student access to mainframe, IBM, Apple, and Macintosh computers. These labs are administered by the university Instructional-Technology-Center (ITC) and most are open seven days a week. The ITC staff works directly with the faculty and support staff of the university to develop ways of incorporating instructional technology throughout the coursework of the Liberal Arts and Science curriculum. In addition, the ITC at present provides access to 43 cable channels as well as the downlinking of teleconferences and other satellite programs through the National University Teleconferencing Network (NUTN) and the Educational Satellite Network (ESN)..

Technology in Teacher Education at NMSU

One particular aspect of this investment in instructional technology is the development of the NMSU Teacher-Technology-Center (TTC), a critical component of NMSU's innovative Master of Arts in Education (MAE) graduate education program. Through the TTC, the university seeks to integrate computer, video, and multi-media technology and to provide prospective, as well as current, educators with training and application opportunities in focusing technology toward instructional improvement, curriculum development, classroom management, active research, and continued professional development.

The Master of Arts in Education (MAE) degree program is the only initial graduate level teacher preparation program in Missouri and the only teacher preparation program at NMSU. The program is designed to provide a nationally competitive teacher education at the graduate level for students who possess a bachelor of science or a bachelor of arts degree in a liberal arts and science field. Many of the MAE students have completed their undergraduate degree at NMSU, however the undergraduate degree can be completed at any other accredited institution of higher education with a liberal arts and science emphasis.

The TTC consists of a multi-media laboratory, a recording studio suite, and a microcomputer center. These facilities are housed and administered within the Division of Education and centrally located in one of NMSU's main academic buildings. The university employs one full time staff member with computer and technology experience to coordinate the TTC and the center is staffed by NMSU students trained in the use of educational technology. The TTC was developed to provide access to and hands-on experience with educational technology for MAE graduate education students in the curricular areas of elementary, secondary, and special education. The TTC staff regularly conducts workshops for students and faculty in the use of newly acquired hardware and computer software. In addition, computer simulations, video and teleconferences, and other special technology projects are included by the faculty as part of the graduate teacher education coursework. Although the primary mission of the TTC is graduate teacher education, the facilities are open to the public and are regularly utilized by undergraduate students, faculty, student organizations, public school teachers, and the general public.

Multi-media Laboratory

In the multi-media laboratory, prospective teachers acquire skills in developing and producing instructional materials for a variety of classroom settings. These materials include grade level and subject specific hands-on student activities, student instructional manipulatives, photography and slide presentations, art projects, photocopies, overhead transparencies, and film presentations. These materials are then utilized by teacher education students in teacher education seminars, classroom simulations, field-based and clinical teaching experiences, and in extended teaching internships in the public schools.

Recording Studio Suite

Through the use of the recording studio suite, the Education Division, with the cooperation of the NMSU Career Placement Center, provides mock job interviews, mock parent/teacher conferences, classroom simulations, and micro-teaching experiences. Videotapes of these experiences are later critiqued by the individual students, teacher education faculty, and/or in group seminars. Through these activities, prospective teachers also become proficient in the operation and instructional applications of video recording and playback equipment. In addition, a current library of videotapes addressing such concerns as classroom management, teaching techniques, and child development is available for student and faculty use. Facilities for access to 43 cable channels as well as the downlinking of teleconferences and other satellite programs are also available.

Microcomputer Center

The microcomputer center, the newest (1991) addition to the TTC, features a Macintosh LC and printer network, file servers, Macintosh Classics, Apple IIe's, Apple IIGS's, IBM 5SSX's, IBM compatible laptops, and IBM multi-media stations. Programs include tutorials, word processing, data bases, spread sheets, desktop publishing, and interactive video simulations. Users are given opportunities to develop instructional and evaluation materials, react to classroom management simulations, learn and apply a full array of student centered academic software for various (K-12) grade levels, and are encouraged to utilize this equipment in innovative and creative instructional applications. Use of this facility enables graduate teacher education students to be more prepared to integrate technology into their planning and instruction during their teaching internships and in their teaching careers after graduation.

Care is taken to provide students with experience and specific training in the quality and variety of hardware and software available for their use in the public school internship. The Coordinator of Field Experiences works with the TTC staff and the teachers and administrators in the public school internship sites throughout Missouri to insure that the integration of technology is a partnership between the university and the public schools. Internship sites are regularly surveyed to assess the type and variety of technology available to our students in the public schools. This data is used to make decisions both on what new technology to acquire and how to best upgrade our technology curriculum. Another example of this coordination is the use of common types of computers and software in the TTC and in the local public school system. In this way, MAE students are able to develop computer skills in the TTC and then utilize those skills using the same hardware and software in the classrooms and computer labs of the local public schools during their classroom observations and clinical field experiences. This collaborative effort allows students to apply their technology skills in actual teaching situations prior to beginning the teaching internship.

Graduate teacher education students also have open access to the NMSU Academic Computing Labs and are provided instruction in utilizing e-mail, MORENET, INTERNET, TELNET, and BITNET both while on campus and during their teaching internships in the public schools. This technology allows these future teachers to broaden their access to research data, increase their contact with university supervisors while in the teaching internships, and provides a network for gathering and reporting data for the research component of the Masters of Arts in Education degree.

Future Plans and Conclusions

The continuing development of the Teacher Technology Center is evidence of the ongoing commitment of the Master of Arts in Education (MAE) program and NMSU toward the integration of technology into the teacher education program. The initial steps of this commitment presented here have been well received by students, university faculty, and by the teachers and administrators in the public schools. In addition to the continuous upgrade of computer hardware and software, as well as increasing holdings in the video library, plans are being made to develop a fiber optic backbone between all university buildings, acquire additional phone lines and high speed modems, and to develop interactive video networks between the Division of Education and the public school internship sites. Through commitments such as this will come innovative and creative teachers who are not only well grounded in their content area but also have the advantages of reflective analysis through video simulations and extensive experience in the integration of current technology for the modern classroom setting.

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Empowering technology and pedagogical innovation: A bar code grade recorder prototype

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Modernity has pushed the curriculum in teacher education out to sea. After once reposing on a solid rock of tradition built on behavioristic methods of instruction, what teacher educators now hope prospective teachers will learn has become vastly larger and more complicated. For example, as the school-age population becomes more diverse, there is a pressing need to help prospective teachers understand the relationships among race and class and schooling (Nieto, 1992). But how much time and effort should be spent exploring these issues? Likewise, teacher educators now have a dramatically enriched curricula with respect to subject-specific pedagogy (McDiarmid, Ball, & Anderson, 1989). When does the tempered teacher educator forego such instruction for other important topics? Moreover, what should prospective teachers be taught about technology? Clearly, teacher educators, like all educators, must face-up to all that they cannot teach; they must stare squarely at the mountain of the null curriculum and decide what knowledge will be priveleged in their programs. Add to the mountain's scree the need to develop teachers who will "teach against the grain" (Cochran-Smith, 1991), teachers who will resist the largely formulaic approaches to instruction and bring significant innovation to the profession. In this paper, we suggest that the molehill of the explicit curriculum in teacher education should include the exploration of technologies that go beyond what is currently available to educators. Indeed, teacher educators interested in technology must be developers of such technology. We also suggest that whatever technology preservice teachers learn they must come to consider essential to teaching. They must consider technology as a tool which they require to do their jobs well. We use as an example the development and implementation of a bar code grade recording system.

Two Views on Technology in Teacher Education

One way to look at technology in teacher education is to see it as a tool for helping preservice teachers understand and use the technology that exists in the schools, those devices which are currently available. If one sees things in this way, the curriculum in teacher education becomes one which attempts to mirror what preservice teachers will likely see when they begin teaching. This approach is tantamount to what has been called the "good employee" approach to teacher education (Doyle, 1991). Another way of looking at technology in teacher education is to view it as a tool for changing the way educators manage their professional lives. From this view, the teacher educator's job is to broaden preservice teachers' analytical sights and help them to engage in instruction that improves on what now prevails in the schools. This approach to teacher education has been called "reflective," among others.

When applied directly to technology, there are two essential paths that teacher education can take. One helps teachers become more informed about the intellectual and emotional growth of their students. The second helps teachers become more reflective and thoughtful about their own profession. That is to say, teachers must come to be aware of their own position in the culture's professional landscape and perhaps the ways in which they are being shortchanged (even oppressed) as a result of being teachers. This second path towards reflection is the one we explore here. Teachers are required by school bureaucracies to carry out bleak administrative tasks, unbefitting of a professional. For example, what other professional is required to record literally thousands of numbers in a ledger and later calculate averages on those numbers. Other professionals in our society are provided with secretarial support for such tasks, increasing the time they have for addressing their true professional challenges. The current teacher/secretary portrait of classroom educators serves to disincline teachers from access to genuine professionalism.

Emancipating Teachers with Technology

The first point of view suggests that technology instruction in teacher education should focus solely on assisting preservice teachers with the kinds of technology that schools currently use, that such a focus might be directed towards technologies impacting student learning. Of course, the problem with this approach is that very little technology exists in the schools. Although we agree that teaching prospective teachers to use the available technology is important, it does not help preservice teachers take on the task of reforming the way teachers now work. We favor instruction in new forms of technology coupled with the skills for obtaining such technology. In this model preservice teachers would be instructed in various systems of empowering technology (those forms which reduce the time a teacher spends on tasks that result from not having a secretary). Alongside instruction in emancipating managerial technology, preservice teachers would also explore instructional technologies, though we contend that these two types of instruction are allied.

What do we mean by emancipating technology? Teachers lament that their administrative demands are growing (Kischkel, 1990), yet very little research and development in teacher education and technology is devoted to developing technology that frees teachers from cheerless administrative tasks. An ERIC search undertaken to discover whether or not this phenomena had been documented revealed no pertinent studies on technological solutions to teachers' administrative tasks. In an attempt to begin documentation, we gave a short survey to the faculty (N = 36) at an elementary school that we believe is fairly typical of most elementary schools. We asked them to report how much time they spent each day or week (a) grading student papers, (b) developing new curriculum, (c) recording student grades, (d) planning lessons, (e) and communicating with parents. Our respondents also reported how much time they spent and calculating grades for report cards.

Their responses revealed that they spent the majority of their time planning lessons and developing new curriculum, both unsurprising findings. More startling, however, was the discovery that these teachers spend an equal amount of time communicating with parents and recording student grades in gradebook (approximately 3 hours per week). Furthermore, they spend an average of 3.5 hours calculating grades for reporting purposes, though this task need be completed just once every six weeks.

What makes this fact so worrisome is that other professionals are not required to spend so much of their day in burdensome "administrivia." The previous investigation endorses the view that teachers are being asked to do more paperwork than they should.

A Bar Code Grade Recorder Prototype

To address this oversight, we have developed for the classroom teacher a bar code reader that interfaces with a Macintosh computer for routine administrative tasks such as recording grades. Our bar code grade recorder, now in the development stage, frees teachers from the dreary task of manual data entry.

The bar code reader is a light pen resembling the type used in many library circulation systems. Bar codes are now very common in what is known as point-of-sale systems and are well-suited for any application requiring quick data entry. Partly as result of their wide use, bar code readers, like the one used here, are inexpensive (often less than $250).

The bar code reader interfaces with the computer via an inexpensive serial interface. Bar codes are incorporated into tests, worksheets, and other assignments in order to automate the recording process. Bar codes are used to identify students, assignments, tests and grades. After grading a set of tests in the usual manner, a teacher would be able to easily record the grades by scanning the bar codes printed on the test that identify the test number and the student. A score card with pre-printed bar codes representing all possible grades would be used to assign a grade for each student.

Bar codes can be added to tests, grade sheets, and instructional materials using two different methods. The simplest technique is to employ software that can produce and print the desired codes on adhesive labels. These are the applied to tests, assignments, worksheets etc. A somewhat more advanced approach involves the creation on tests and other material with the bar codes already in-

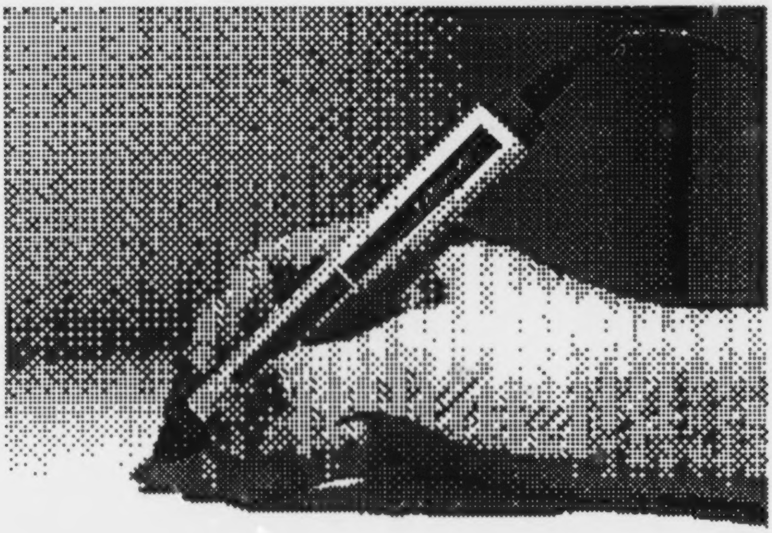

Figure 1 illustrates the reader used in our system.

place. This approach requires desktop publishing software and other utilities that, at present, are not widely available. To streamline the grading a process the teacher could prepare a sheet of bar codes representing each student in a class.

Conclusion

Bar code grade recorders, along with other inexpensive technology may assist teachers in focusing their professional energies in directions that are truly professional. We argue that such emancipating technologies must be incorporated into teacher education curricula. In the proposed preservice teacher education program, students are instructed in how to use this bar code grade recorder system with the hope that they would come to see such technology as indispensable to their profession. Teachers must begin to view technology as critical to their job. Teacher education might be the place to start this new vision.

The central task of those in technology and teacher education should be the development of empowering technology, presented alongside methods for obtaining such technology. Teacher educators must act as the creative, reflective agent in the process of teacher change. The bar code grade recorder project presented here may act as a map for this kind of endeavor.

Although the bar code grade recorder is not necessarily designed to improve instructional practice, this technology might assist the teacher in developing other technologies that would impact students directly. Pedagogical innovation often occurs when teachers gain mastery over a technology themselves, then introduce it to their students. Take word processing as an example: First, hundreds of teachers learned to use a word processor, then they found it an indispensable part of their professional lives; then, with verve and enthusiasm, they taught their students how to use word processors. Students then caught their enthusiasm and a proclivity to become excited by technology.

Here is a scenario, one among many, that may occur as a result of a bar code grade recorder. A teacher becomes familiar with bar code technology and finds the grade recorder a useful instrument. While daydreaming in the checkout line at the department store, she notices that the checker has a deluxe bar code reader and wonders what would happen if her students all had bar code pens. Ideas tumble forth and a new application is born. What if all her students had a light pen at their desk and they could answer questions by passing a light pen over a bar code at their desk? And what if their pens were all connected to a computer that would display the bar codes the students chose? An instant record of student responses would be created. No longer would students need to raise their hands and be embarrassed by an incorrect answer. They could simply pass their pen over the correct response. She could tell who was understanding the lesson by glancing at the monitor. Students would no longer feel embarrassed by answering incorrectly. Perhaps lessons could come with its own question sheet with bar codes printed right on them. Perhaps each student could use their light pen to enter other types of information?

It is our contention that prospective teachers must learn to use technology that is not yet available and encouraged to think in ways yet unexplored. Teacher educators must lead the way. New technology carries with it the mandate to emancipate teachers from the tedious tasks they have historically be asked to perform. We have provided one example.

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Training inservice and preservice teachers about videodisc technology: Resources for trainers

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Introduction

Videodisc technology is becoming increasingly useful and popular in education. Over fifty per cent of the school districts in the United States report that they are using videodiscs (Quality Educational Data, 1991). The benefits of using videodiscs in instruction include a reduction in learning time, increased mastery of subject matter, increased retention, more consistency in instruction, faster and easier access to information, and greater motivation and learning enjoyment (Hasselbring, 1988; Miller, 1990; Montgomery & Sayre, 1989).

Recently, the state of Florida provided a videodisc player for every public school in the state. While this was certainly a positive move for Florida educators and for technology in education, it provided an immediate and unique challenge for staff development in schools and school districts throughout the state. Teacher training programs were also faced with a need to provide training about videodisc technology to future teachers. This paper describes the products and services developed at the University of Central Florida to support the implementation of videodisc technology in Florida schools.

Background

The University of Central Florida's Instructional Technology Resource Center is funded by the Florida Department of Education to provide information to Florida educators about new and emerging technologies. Originally funded to provide information about computer literacy to Florida schools, the Center has distributed print and non-print materials about new technologies, including CD-ROMs and interactive videodiscs, to educators for several years. A series of reproducible brochures, entitled "What Every Educator Needs to Know about the New Technologies," has been produced and distributed by the Center. A quarterly newsletter, distributed to every school in the state, provides timely news about technology in education, and several issues have featured articles on videodisc technology. Because of its work in informing educators about emerging technologies, the Center was uniquely poised to offer support for educators attempting to integrate videodisc technology into their school curricula.

The announcement of the funding of videodisc players by Florida's Commissioner of Education, Betty Castor, provided the impetus for the Center to develop materials to support the initiative. Products and services were developed in several phases.

Phase I

The Center staff gave immediate priority to supporting this initiative. There was approximately a three month's lead time between the announcement of the funding and the delivery of the videodisc players. Because additional funding was not available to the Center at this time for this project, low cost alternatives were discussed. The following strategies were developed: 1) to update and revise the new technologies brochures series; 2) to develop a special videodisc issue of the Center's quarterly newsletter, *The Printout*; and 3) to explore the cost of a toll-free hotline for educators to use to get information about videodisc technology.

Brochures. Three brochures of the "What Every Educator Needs to Know" series were updated and revised to include information appropriate for the capabilities of the model of videodisc player being provided for Florida schools. These brochures are "Laser Videodiscs," "Interactive Video 1," and "Interactive Video 2." Brochures are issued in three formats: finished copies (printed on colored paper and folded in thirds); camera ready (reproduced in black on white so that they can be easily reproduced); and disk files (PageMaker 4.0 for the Macintosh).

Newsletter. A special double issue of the Center's quarterly newsletter, *The Printout,* was developed and distributed. The issue focused on videodisc technology, and many articles were specific to the Pioneer 2200 videodisc player. This newsletter issue includes terminology and definitions, advantages and disadvantages of the technology, information about levels of interactivity, formats, videodisc care, equipment set up, use of the barcode reader and remote control, repurposing, and curriculum integration. Also included are a listing of producers and distributors of videodisc products and a bibliography. The issue was mailed to schools at approximately the same time that the videodisc players were distributed. Like the brochures, the newsletter is also available in three formats.

Videodisc Hotline. The possibility of providing a toll free number to support educators who have questions about videodisc technology was explored. The rates for an in-state 800 number were actually lower than the state's telecommunication system and significantly lower than regular intrastate rates. Many educators reported that while access to a phone was difficult, long distance calls were almost impossible from the school. An 800 number was installed on a trial basis and advertised as a "videodisc hotline." Although not all questions are videodisc related, the hotline has been extremely popular and cost effective, and teachers and administrators have rated it as one of our most valuable services.

Phase II

The second phase of the project included the design and delivery of workshops and the establishment of a videodisc preview center. Site-based, hands-on training on how to use and integrate videodisc technology was designed and developed. A variety of workshop formats were implemented in an attempt to meet the needs of a variety of groups (organizations?) who contracted with the Center for training. After a number of workshops, a "train-the-trainer" format was determined to be the most beneficial to most school districts. Materials used in the training by the Center staff were distributed to the participants for use in their own training. The videodisc issue of *The Printout* became the basic "text" for the workshop. The Videodisc Trainer's Tool, a hypermedia stack for use in presenting workshops, was developed in both Linkway and HyperCard. Activities for learning about videodisc technology were developed, implemented, and refined.

In cooperation with a number of videodisc companies, a videodisc preview center was established at the University of Central Florida Videodiscs, both level 1 and level 3, may be previewed at the center or checked out for evaluation in schools. Educators may visit the Center to select videodiscs, or they may request videodiscs by phone or FIRN (Florida Information Resources Network), the state's telecommunication network; videodiscs are mailed to the schools.

A computer-assisted instruction (CAI) program was also developed; the first version was in HyperCard for the Macintosh computer. The design has been used to create a Linkway version for the MS-DOS platform, and a HyperStudio version for the Apple //gs. The program includes optional pre- and post-tests, the option to use the program at level 1 or level 3 (the program was correlated to an inexpensive videodisc about videodisc technology produced by a Florida educational consortium), and four main menu items: an overview of videodisc technology; more in-depth information about videodisc technology and its use in the classroom; a videodisc "sampler"; and the program exit. (See figure 1.)

The CAI program can be used by educators to work at their own pace to learn about videodisc technology. It can also be used to review material presented in a workshop or to expand upon concepts introduced by a trainer. In some cases, trainers with little or no experience with videodisc technology have reported using the program to prepare for a workshop.

Phase III

In the current phase of the project, the Center is packaging materials for use by trainers in a variety of settings. These staff development materials include the materials developed in the first two phases, many of which have been revised an updated, and more. For example, the videodisc issue of *The Printout* was revised

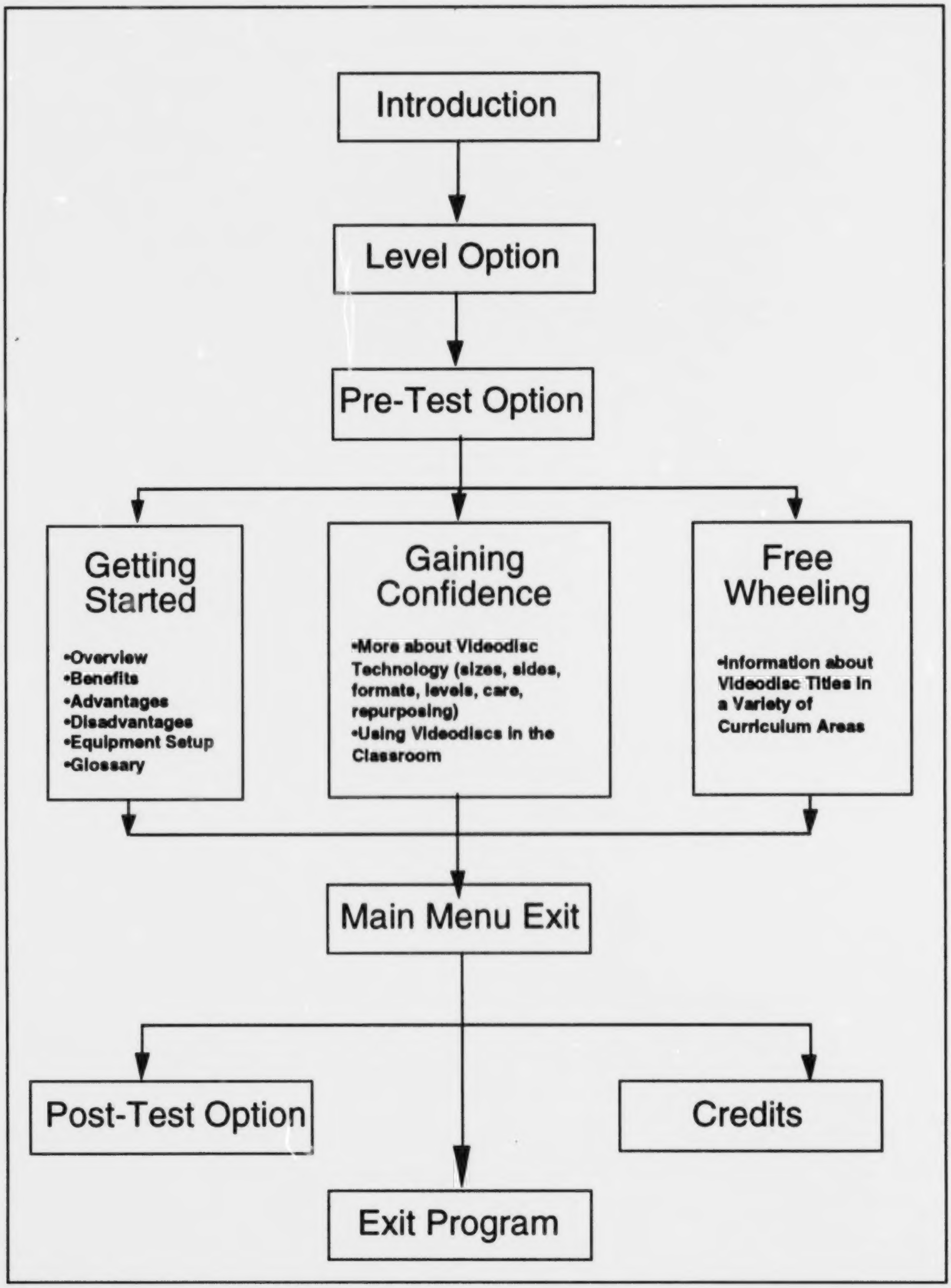
Introduction
Level Option
Pre-Test Option
Getting Started
•Overview
•Benefits
•Advantages
•Disadvantages
•Equipment Setup
•Glossary
Gaining Confidence
•More about Videodisc Technology (sizes, sides, formats, levels, care, repurposing)
•Using Videodiscs in the Classroom
Free Wheeling
•Information about Videodisc Titles in a Variety of Curriculum Areas
Main Menu Exit
Post-Test Option
Credits
Exit Program

Figure 1. Structure of CAI Program

to include new titles, more producers, and information about the Pioneer 2200 and the Pioneer 2400, which is currently on state contract for purchase.

New materials include transparency masters of the Videodisc Trainer's Tool, camera-ready directions for workshop activities, ideas for using barcodes with videodiscs, lesson plans and workshop outlines. The resource also includes descriptions for all "Training Wheels" components and disk files whcih contain an enhanced public domain barcode generation program, and a hypermedia template for use in demonstrating and creating level 3 programs. Over 1500 copies of the "Training Wheels" package have been distributed. All the materials are free and may be reproduced without charge for use in training provided credit is given to the Instructional Technology Resource Center, University of Central Florida, and the Florida Department of Education.

Currently, a study is being conducted to compare the immediate cognitive recall, retention, attitude, and practical application by learners experiencing different forms of training related to videodisc technology; an additional variable of learning style, cognitive style, or attitude toward technology is also being explored.

Acknowledgements

This project was developed under a grant funded by the Florida Department of Education, Bureau of Educational Technology.

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Image processing for teaching project: Innovative inservice education

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Background

The challenge of integrating microcomputers effectively into science and mathematics class rooms remains a daunting one. Researchers note their static and stilted use. Gallagher (1987) remarks that cognitive applications of computers are not common in most schools. Brown etal. (1989) point out that science teachers typically do not use computational resources in the same way as research scientists, that is, as tools for inquiry and discovery. Since the inquiry process is at the core of what is interesting and exciting about science, using computers for these tasks is both intuitive and potentially very productive in inquiry-based learning.

The "Image Processing for Teaching" (IPT) project, sponsored by NSF, Apple Computer, and the University of Arizona, addresses this problem. IPT provides a powerful medium to excite students and teachers about science and mathematics through the use of digital image processing on microcomputers. We have found this approach to be especially effective for children from minority groups and others whose needs have not been met by traditional "coded" ways of teaching these subjects.

Image processing was developed to facilitate the process of exploration and discovery in the research community. It is, therefore, an intrinsically "constructivist" medium when used by schoolchildren (Yager 1991). Its productive use in the classroom requires abandonment of traditional "behaviorist" ways of using technology for teaching (e.g., Skinner 1968). The IPT project offers access to imaging data from various disciplines too extensive to have been fully explored by the scientific community, and it offers a student the power to see that data in novel and unique ways. The door is open to original scientific discovery.

Many students and teachers, perhaps most, are visual learners (Stensrud and Stensrud, 1983). For such people, manipulation of images provides an attractive entree into science and mathematics. This is especially important for students from diverse linguistic or cultural backgrounds. Certainly, in the formal sense, images convey information to the brain orders-of-magnitude faster than words or other codes. For all students, learning through image manipulation can complement and enhance language-based instruction.

Image Processing

Image processing allows pictures of photographic quality to be digitally manipulated through a computer. Processing can include contrast enhancement, false coloring, animation, filtering, etc. The technology has been driven to a great extent by spacecraft exploration of the solar system and by biomedicine, and has advanced to the point where sophisticated systems are available for microcomputers.

A few points about image processing technology should be noted to appreciate its potential importance for education. Most educational use of image media, even computer-accessed images in high-tech media, employs pictures in an analog way. In other words, the images are typically obtained and stored in non-numerical form, or they are digital images with no way to access the actual data bits. In contrast, the essence of image processing is that we manipulate digital images: an image is in fact a spatially displayed set of numerical data. This format allows scientists, and now school children, to manipulate the original bits of scientific data into new and unique forms.

We emphasize that these images are not just pretty pictures. They are the original data sets from recent research in a wide variety of disciplines. Teachers in our program and their students manipulate the original data sets as they do their image processing. This capability, combined with the sheer magnitude of the available data set, allows the prospect for significant original scientific discovery in image processing.

The implications for use by students are profound. Most of the images we have distributed are quite beautiful. Manipulating them is fun, and gives children a great sense of empowerment. Moreover, since we use Macintosh computers, the mouse-driven processing (contrary to the parameter-driven processing done by most scientists) means that as students move from one processed version of an image to another, they move through an infinite range of versions that have never been seen before. Again, the prospect for original discovery is very real, which can be a heady idea for children.

Because image manipulation on our systems can be started without much understanding of the underlying mathematics, the student can have an authentic scientific inquiry or discovery experience without reliance on traditional (language or math) coded methods of teaching. This process allows us to effectively reach visual learners and non-traditional populations. Nevertheless, image processing at its base is a mathematical operation. The children may not be thinking about mathematics in the beginning, but as they manipulate images, they start thinking in mathematical terms, and understanding concepts such as arrays, set theory, slope, and intercept.

Preliminary indications show image processing to be an effective and fun way to study the application of science and mathematics to "real world" applications, as represented by digital imagery. Also, as the teachers and their students begin to use image processing, they are drawn into inquiry and discovery-based learning, to the point of capturing or creating their own images to analyze, allowing teachers to use the students' interests to import science into the classroom. Allowing students to create their own images opens up a tremendous opportunity to motivate them to be interested and excited about science.

Results

Exciting things are happening with IPT in the classroom. Image manipulation is attractive and fun, but it inevitably leads to exploration of the scientific content, and appreciation of the mathematics that is built into the process on many levels. IPT nurtures the investigative processes of science in children. We find great success and interest by children who might not have been expected to do well in conventionally taught science classes.

While our funding does not yet include a large-scale research project to study the effects of IPT, the follow-up and evaluation process built into our development-and-test phase has demonstrated a number of results, some of which were unexpected.

1) *Under-represented groups:* The project is proving to be an exceptional way to reach previously under-represented groups of students. We are having success with minority groups, females, students with limited English proficiency, so-called "learning disabled" children, etc. With image processing, traditional obstacles to doing mathematics and science are largely eliminated. At the same time, for gifted and talented students from all groups, IPT offers challenging and unlimited possibilities for advancement and enrichment, using a professional scientific research tool.
2) *Mathematics:* While our original expectation was that IPT would have an impact on teaching science, we have been impressed at the effect it has on motivating and enriching study in mathematics. Our participating teachers realized this immediately. Independent of the content of an image (many of our teachers introduce image processing with images of cars, rockets, or the children themselves), manipulation is rich in mathematics. Just by playing, students become familiar with coordinate systems, numerical arrays, scale, histograms, look-up tables, etc. Some teachers use the gray scale map in NIH Image to teach concepts of slope (contrast) and intercept (brightness). More advanced students delve into the technical details of the software and quantitative analysis to a level much deeper than anticipated.
3) *Students outlook on life:* A repeating pattern at a wide variety of our participating schools involves numerous "at-risk" students whose negative views of themselves and of the world have been substantially turned around by our expert teachers using image processing to provide the students with a reason to come to class. Students viewed as being on paths leading to flunking out of school are now highly motivated to do extra

work in image processing, to take leadership roles in training other students, and to become serious students.

4) *Effects on teachers:* This project was begun to explore the potential role of this new technology in education. The teacher education segment was regarded as a means to that end. However, from our various feedback and evaluation efforts, we have found that teachers' perceptions of subject matter, pedagogy, and their own professional role have been profoundly affected in some fairly consistent and important ways:
   a) We have been interested to observe the extent to which participating teachers have become acculturated to the social and intellectual processes of scientific inquiry. Teachers' repeated comments show their increased capabilities for incorporating such reform into their teaching.
   b) They seem to become activists for change in a variety of ways in their schools.
   c) Professional motivation is revitalized both among the veteran and the more junior teacher-participants.
   d) The IPT project has stimulated our teacher-participants to develop continuing cooperative projects among themselves and with members of the scientific research community.
5) *Middle-school success:* In its experimental spirit, our project has included teachers from the upper elementary grade levels through high school. Given the objective of introducing high technology, we anticipated that IPT would be most effective at the upper grade levels of high school. In fact, IPT is proving to have the greatest impact at the middle-school levels for two reasons: First, science curriculum is not rigidly defined for those grades, so teachers have flexibility to incorporate innovations. Second, the students are much more open to the spirit of exploration and discovery. In contrast, high school Physics and Chemistry are bound to a traditional curriculum, with students who are already locked into the grade-and test-oriented system. Our teachers have successfully introduced IPT at all grade levels from 4th grade up and all science areas, but their greatest success at integration has been in the middle school grade range.
6) *Contributions to research:* Equipped with this state-of-the-art technology, our teachers and their students have had an impact on the research community. The IPT project has, for example, introduced image processing to tree-ring research, influenced the continuing development of software at NIH, provided a standard system adopted by NASA Planetary Geology and Geophysics, and developed new techniques for 3-D imaging. The significant two-way communication between teachers and researchers has enriched both groups. This interchange is a strong and unique feature of the IPT project. For example, a group of high school students working on a project on Mars with some university researchers recently presented their results at an international conference on lunar and planetary research.
7) *Most effective teachers:* As part of our experimental approach, our team of teacher participants includes a variety of different subject area specialties, grade levels, and background strengths and weaknesses. Initially, we expected that the most effective participants would be those with the strongest scientific and technical backgrounds. In fact, in the schools, we found that other characteristics were at least as important for effective integration of IPT into schoolwork and curriculum. In this regard, our most successful teachers were those most pedagogically enlightened and flexible, with energy, enthusiasm and administrative acumen.
8) *Availability of hardware:* When we began this project, the standard system for each of our teachers cost about $6K. While this price was acceptable for our development and test project, it was not consistent with widespread dissemination. In less than two years, the price of this capability has dropped to under $2K with introduction of the Mac LC. Many school districts are now buying large quantities of these machines. For example, the large Tucson Unified School District has decided to use its Technology Bond for a massive purchase of this hardware, largely motivated by their familiarity with IPT. By the end of this academic year (1992-93), all of the high school science teachers in the Tucson Unified district will have been educated in image processing. We know of other districts that have purchased these machines, but are not using them effectively or at all! In all these cases the need is for teacher training and education.

Dissemination

After a successful development and test phase, we are now widely disseminating the results of our project through on-site in-service workshops. We have worked with a variety of districts on different implementations, ranging from a small group of teachers designing new curriculum to a large, urban district's entire high school science staff. The participating teachers are enthusiastic about the in-service education, in particular they very much benefit from the multiple day-long sessions. In fact, many have remarked that this experience of having multiple days to practice and think about IPT is unique in their careers.

We have developed a number of avenues for follow-up help and feedback to the learners. While we are unable to be in every classroom, we have developed a number of ways to gather feedback and connect different people involved in this project. In order to better enable teachers in various locations to share ideas and data with others, we have created an electronic network linking the teachers who have participated in the various stages of the Image Processing for Teaching Project. This network, along with a technical support telephone line, enables all of the science and math teachers involved in this project to more effectively use computers in their classes.

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INTEGRATING TECHNOLOGY INTO METHODS CLASSES

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The integration of technology and teacher education is a blend of thinking, learning, and instruction using tools of technology to form an entire educational system. This kind of blend necessitates that teachers have easy accessibility and understanding of the potential of technology (Sheingold, 1991), as well as education in the use of technology by a process of modeling and active involvement which requires teachers to be active participants in their learning (Copley, 1992). New teachers entering the field of education should be shown how to realize the potential of technology and how technology can help to restructure the learning environment (Solomon, 1992). Models of effective teaching with technology must be demonstrated, and then the trainees should be given real classroom opportunities for replicating the experience and for experimenting with new ideas that involve technology.

Callister and Dunne (1992) remind technology enthusiasts of a basic fact. Machines are tools and valuable only when an intelligent being uses them in a productive manner. They fail to point out, however, that effective teaching with technology is much more involved and difficult than responsible use of the technology. Those outside the education community, who use computers and calculators everyday and ridicule teachers for not changing the way they teach, do teachers a disservice. They fail to recognize the many facets involved in teaching with technology.

The integration of technology into the curriculum empowers the teacher to create a rich learning environment but demands many changes. The role of the teacher changes from that of "teller" to "guide", the questioning techniques change so as to encourage student communication and to shift the focus from "product" to "process", progress monitoring and cooperative groups of students become necessary, and active student participation in their own learning becomes possible. Such changes, however, require not only that the teacher be knowledgeable of the technology that the students are using, but also expert in subject area matter, learning strategies, classroom management, and human motivation. In truth, most teachers (both inservice and preservice) require training to make these changes attainable.

The papers in this section describe the plans and experiences of several university faculty members who have begun to integrate technology into their methods classes for preservice and inservice teachers. They share an understanding of the importance of integration, along with the belief that modeling and involvement are essential to the process. While the specific concentration on subject matter varies (e.g., language arts, reading diagnosis, special education), each paper details how their programs have been designed to meet the needs of their preservice or inservice teachers.

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Dave Edyburn at the University of Wisconsin-Milwaukee offers an integration process model for classroom-level change. The pilot project was designed to capture the potential of technology in specific applications that contribute to teaching and learning in special education personnel preparation programs. The project has sought to develop extensive course-by-course resource guides of instructional objectives linked to specific technology tools and resources. The integration process model appears to have applications in higher education as well as at the K-12 levels.

French, Landretti, and Tutolo at Bowling Green State University compare perceptions of students in a technology-infused section of an integrated reading/language arts methods course with those in a control group secion in which computer technology is not infused. They describe specific activities that were designed for the technology-infused methods course (e.g., electronic journal activities, writing assignments which involved technology, and required attendance at a regional technology conference). The results of pre and post questionnaires which were distributed to students from both sections of the integrated reading/language arts methods course, summarize the gains of each group and identify the activities that the students perceived as most effective.

A new approach to teaching reading diagnosis at Georgia Southern University is presented by McKenna and Clark. They describe the merging of concept-based learning with case-based learning through the use of hypertext portfolios. Portions of a diagnostic text have been linked by means of HyperCard to an extensive set of data for a single child. Graduate students in reading diagnosis courses have been immersed in the system and allowed to examine textbook passages and student data in any manner. The goal is to determine whether the students' understanding of diagnostic principles and thinking improves as a result of the experience.

Bauer and Westhoff at the University of Northern Colorado describe a model for integrating technology across the curriculum. The model was designed to allow students to engage in meaningful hands-on experiences with various technologies. Details about the resulting project, The Earthquake Club, are shared and interview data collected from undergraduate and graduate students involved in the project is summarized.

Looking Ahead

The process of the integration of technology into methods classes is time-consuming, difficult to define, and even more difficult to assess. While the papers in this section represent a sample beginning to that process, other approaches certainly need consideration. Perhaps, a model of integration that could be implemented in any methods course needs to be designed, developed, and investigated. At the very least, the results of the studies presented here need to be experimentally studied and the results reported; the possible findings could significantly contribute to a comprehensive model of integration.

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Models of technology integration for special education personnel preparation programs

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Consensus about the importance of integration into curriculum is apparent (Hanley, Appell, & Harris, 1988; Morocco & Zorfass, 1988; Panyan, Hummel, & Jackson, 1988; Royeen, 1988; Office of Technology Assessment, 1988). A considerable gap, however, exists between potential and practice. Concerns of this nature have been voiced by MacArthur and Malouf (1991) and Vockell (1990) who have noted that little attention has been given to the theoretical principles or specific instructional strategies which effectively utilize technology to enhance student learning. The practices listed below could be considered as possible examples of effective integration of technology into a course.

- a discussion of the technology applications described in the course textbook
- the inclusion of an outside speaker for one session during a course to discuss and demonstrate relevant technology tools
- an assignment that involves the independent use of technology outside of class
- the use of technology to aid an instructor in the presentation of course content
- the use of a specific software program or technology tool to contribute an experience that is essential to mastering a given course objective

These diverse examples illustrate a lack of consensus about what technology integration is and what it means to use technology well. Furthermore, integrating the computer into the curriculum is difficult work with few resources and models to facilitate the task. Despite the perceived importance of integrating technology into the curriculum, there seems to be few resources, strategies, and tools to assist special educators in capturing this vision of the effective use of technology.

One Model of the Integration Process

The Integration Process outlined in Figure 1 was developed as a result of the following perceptions.

- Integration involves more than simply evaluating software (Smith & Vokurka, 1990).
- Considerable time, energy, and resources are necessary to successfully integrate technology into the curriculum.
- Not all the tasks involved in integration are necessarily the primary responsibility of the teacher.
- A number of stakeholders are involved in the successful integration of technology in special education programs.
- Many integration models are based on system change and provide little guidance for motivated individuals to pursue the integration process at a classroom level.

Figure 1

The Integration Process

PHASE 1	PHASE 2	PHASE 3	PHASE 4
SELECTION	ACQUISITION	IMPLEMENTATION	INTEGRATION
Planning	Previewing	Organizing	Linking
Locating	Evaluating	Teacher Training	Managing
Reviewing	Purchasing	Student Training	Extending
Deciding			

Figure 1. The Integration Process.

The development of a model that describes the various tasks involved in integrating software into the special education curriculum (a) provides a planning guide for interested individuals, (b) serves as a tool for discussing the process among the major stakeholders, and (c) assists in the identification of methods and resources for facilitating the process.

Application of the Integration Process

In addition to the K-12 applications, the integration process appears to have applications in higher education as well. This pilot project was designed to explore how to capture the potential of technology in specific applications that contribute to teaching and learning in special education personnel preparation programs. The project seeks to develop an extensive course-by-course resource guide of instructional objectives linked to specific technology tools and resources.

The development of a comprehensive resource guide seems valuable for several reasons. First, the resource guide would provide an economical delivery system for information that presently requires a personal consultation by a technology specialists. Second, the resource guide would reflect a variety of strategies for integrating technology into individual courses with due consideration for budget constraints. Third, the compilation of the resource guide would provide an information system that would allow teacher educators and technology specialists to enlarge the knowledge base of technology tools and strategies for enhancing teaching and learning. Finally, the resource guide would assist a special education department in examining the systematic use of technology through out its preparation program.

The goal of integrating technology into the curriculum is to link software, computer activities, and other technologies with specific objectives in ways that facilitate teaching and learning. This view is commonly referred to as curriculum correspondence. Utilization of the principle of curriculum correspondence results in computer use that is focused, purposeful, manageable, and enhances students' abilities to master specific instructional objectives. Faculty members may wish to consider two methods of using the principle of curriculum correspondence to integrate technology into their courses.

One method uses software that has been designed to teach instructional concepts at the college level. These types of programs facilitate learning course content and may be referred to as computer assisted instruction. This approach to using computers in the college curriculum provides a model for teachers to use computer assisted instruction in elementary and secondary classrooms. The chief drawback to this approach is the limited amount of software which has been designed to provide college level instruction in special education.

A second method of using software in keeping with the principle of curriculum correspondence provides students with the opportunity to identify and use instructional software that is appropriate (e.g., exceptionality, content area, ability level) for the students with which they will be working. Essentially, this approach treats microcomputer software as another instructional material with which teachers need to be familiar. Course activities and assignments which allow teachers to gain experience with a variety of software programs will facilitate the subsequent use of software with students.

Initial efforts

The first task in the integration process is "planning." As part of this task a faculty member is asked about the courses he/she teaches and the content in each. The course syllabus is used as a starting point in an effort to identify the complete array of objectives for a given course as well

Technology Integration Planning Form

Faculty Member Name: Dr. XXXXXXXX
Course Number: SPED 3400 **Course Title:** Advanced Trends and Issues in Behavior Disorders

Course Objective	Possible Technology Tool	Comments
Design behavioral interventions based on case study data	**Discipline Diagnostician**, ($54, Apple and IBM versions). Exceptional Innovations, P.Box 6085, Ann Arbor, MI 48106; 419/536-8560	Expert system that is designed to suggest interventions for various situations reguiring discipline.
Design behavioral interventions based on specific academic and social behaviors	**Teaching Episodes: Resources for the Analysis of Instruction**,($250,Videodisc). MECC, 6160 Summit Drive North, Minneapolis, MN 55430; 800/688-MECC	This level II videodisc presents a variety of teaching situations that can be used in teacher ediucation.
Provide optimal and age appropriate learning environments	**Choices, Choices** and **Smart Choices**, ($119.95 and $89.95, Apple and IBM versions). Tom Snyder Productions, 90 Sherman Street, Cambridge, Ma 02140; 800/342-0236	Designed for grades K-5 and 4-12 to have students make choices and examine the consequences.
Provide optimal and age appropriate learning environments	**The Other Side**, ($69.95, Apple and IBM versions). Tom Snyder Productions, 90 Sherman Street, Cambridge, Ma 02140; 800/342-0236	A simulation that requires cooperation and conflict resolution skills in a world with conflicting values and interests.
Assess student academic progress toward instructional goals	**Sheri**, ($139, Apple). Performance Monitoring Systems, P.O. Box 148, Cambridge, MN 55008; 612/689-2688	A data base management program that stores and graphs student performance data.
Assess student academic progress toward instructional goals	**Monitoring Basic Skills Progress: Basic Math, Basic Spelling, and Basic Reading** ($249, Apple). Pro-Ed, 8700 Shoal Creek Blvd., Austin, TX 78758; 512/451-3246	Three separate programs that administer parallel tests to enhance teachers' instructional decisions.
Communicate with other professionals and participate in on-going professional development	**BD.ED Board on SpecialNet** (montly subscription fee, access with any computer). GTE Educational Serivces, P.O. Box 619810, D/FW Airport, TX 75261; 800/927-3000	An electronic bulletin board connecting interested teachers, administrators, teacher educators, and parents from across the country.

Figure 2. Technology Integration Planning Form

as any target objectives that are especially important, difficult to learn, or difficult to teach. The goal is to identify topics or objectives in the special education teacher education program which have the potential to be enhanced through the use of technology at either the college or K-12 level. This information is subsequently utilized in the search process by providing a structure for the project staff to conduct searches of the literature, public domain materials, and commercial materials for pertinent technology competencies, topics, and products which might be incorporated into a given course.

The purpose of the second task in the integration process, "locating" is to prepare a comprehensive list of potential technology tools which can then be scrutinized in subsequent phases on the process. A resource guide was developed and used to search for appropriate software and technology tools given the broad definition of technology to include computers (e.g., Apple, IBM, or Macintosh), peripherals (e.g., adaptive devices) and stand-alone technologies (e.g., videodiscs, information services).

Sample Outcome

To examine the utility of the integration process for this project a course was selected, "Advanced Trends and Issues in Behavior Disorders," in which to pilot the procedures. Discussion with the instructor and a review of the course syllabus provided the necessary information to initiate several searches. A sample copy of the results of this search is included in Figure 2.

The next tasks of the integration process involve collecting published reviews of the materials on this list and making some decisions about which materials will be personally reviewed by the instructor. After these decisions are made, the integration process moves into the "Acquisition" phase in which the materials must be ordered for preview, evaluated for their instructional value, and purchased or returned. The "Implementation" phase involves engaging in the necessary inventory and storage procedures, and providing training for both the instructor and the students on the mechanical operation of the program or tool. The "Integration" phase involves linking the use of the program or tool to specific course objectives, managing student use of the program, and extending the value of the learning experience.

It is worthy to note that the type of technical expertise necessary to assist a faculty member in identifying and selecting technology tools for a given course is especially important at the outset of the process. As technology issues decrease, instructional issues increase, and the focus is shifted from "shopping for technology" to discussions of effective teaching and learning tools.

While a formal evaluation of this project has yet to be conducted, the reaction of a small group of teacher educators has been encouraging. The resource guide appears to hold promise for special education teacher educators who are motivated to effectively integrate technology on a manageable scale with due consideration for the costs involved. However, the ultimate success of this project may be viewed as the increased dialogue that the resource guide stimulates concerning the effective use of technology in the preparation of special education personnel.

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Enhancing use of computer technology in an integrated reading/ language arts methods class

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Introduction

A continuing concern in many preservice teacher education programs is how to integrate computer-based activities into specific content methods courses (Bauer & Grzenda, 1991; Beaver, 1991; Biglan, 1992; Dershimer & Dershimer, Jr., 1991; Handler, 1992; Munson, Westhoff, Bauer, & Smith, 1992; Pacciano, 1992; Stephen & Ryan, 1992; Ware, 1991). Many of these studies deal with specific initiatives to infuse technology in required methods courses. This is most often done by including assignments and activities in which computer applications are applied. Accordingly, in an effort to address this concern, specific computer applications (especially using the Apple Macintosh family) were included in a semester-long integrated reading/language arts methods course at Bowling Green State University. The goals were 1) to allow students to use content learned previously in required computer literacy courses, 2) to provide activities which would enhance each student's feelings of expertise and confidence to use technology in classroom-based field experiences, and 3) to compare perceptions of students in a technology-infused section with those in a control group i.e., a section which neither infused or delimited the use of computer technology.

Subjects

The students who were included in the technology-infused (TI) section (n=24) were participating in a pilot methods project which involved an integrated reading/ language arts section taught in a local elementary school. The instructors for this class were two professors and a graduate assistant. One professor had extensive experience using computers for instruction while the other had little computer experience. The graduate assistant had moderate experience using the Macintosh for the instruction. This instructional team assigned specific assignments in which technology was to be used. In addition, they regularly encouraged students to use computers whenever and wherever appropriate. In addition, this section was given additional access to computer labs in the education building.

The students who comprised the control group (CG) section (n=26) were participating in a regular methods program taught on campus. Their only participation was to complete the survey items pre and post. The instructors for this section did not encourage nor limit the use of computers in the course.

Most of the students in these sections had completed the required computers in education course taught in the elementary education program. A limited number, less than 4 per section, had not completed this course.

Activities

In this experience, students in the technology-infused section completed the following applications.

Electronic journal

Students composed a learning log using Macintosh word processing programs (e.g., Word 4.0 and Works). A minimum of nine samples, each consisting of a minimum of 30 minutes of writing were elicited over the course of the semester. In completing this electronic journal, students used a network file sharing system in a clinical laboratory as well as other computers, either their own or in other educational settings. These journals were assigned on a regular basis during the course and collected at specific intervals. Feedback was given to the students on a regular basis.

Required assignments involving technology

Students used the Macintosh to write four summaries of selected children's literature. Students were given a particular format to follow for this assignment. Students were asked to incorporate computer applications into the writing of a class book of language experience stories. In completing this assignment, each student participated by taking dictation from a third grade child. Each student was then responsible for composing a page for a class book which was given to the third grade classroom. Student were also encouraged to use technology in the creation of a student worksheet developed for a reading lesson. For example, many students used word processing for formal lesson plan development.

Attendance at a regional technology conference

As a class field activity, the entire class attended a regional technology conference held at a local high school. Attendance at this conference enabled students to hear and see different applications including a range of educational technologies.

Tutoring

As part of the field based activity, several of the students in the section were able to assist the school library specialist with weekly computer lessons. These lessons dealt with Apple IIe applications and were taught to children in grades K-2.

Results

In order to evaluate the effectiveness of these activities, data were collected: A pre-course questionnaire with questions dealing with the use of Macintosh, Apple II, and IBM computers was distributed to students both in the technology section and control group. Students were also asked how confident they felt in their ability to teach with computer technology in general. A nine-point Likert scale was used. Expertise was ranked from 1 (low) to 9 (high) on this instrument. The results are presented in Table 1.

As indicated in Table 1, both groups felt more expert in their use of Macintosh than either Apple II or IBM computers at the beginning of the experience. Both sections reported mid-range confidence in their abilities to teach with microcomputers. T-tests showed no significant differences between sections.

A post-course questionnaire was distributed to both sections at the end of the classroom experience in early November. This questionnaire repeated items from the pre-course form. Both post-assessment surveys included an item asking the likelihood that technology would be used in future during the 4-week field experience. In addition, the TI section also received a questionnaire dealing with the use of technology in their reading/

Table 1
Means and Standard Deviations for Technology-Infused (TI) and Control Group (CG) Pre-Assessment Surveys

	TI (n=24)			CG (n=26)		
Item	Mean	SD	Range	Mean	SD	Range
Level of expertise using:						
Macintosh	5.7	2.3	8.0	5.9	1.9	8.0
Apple IIe	3.9	2.3	7.0	4.2	1.8	7.0
IBM/clones	2.8	1.8	6.0	3.7	1.7	7.0
Level of confidence using microcomputers for instruction	5.1	2.1	8.0	5.9	1.3	5.0

Table 2
Means and Standard Deviations for Technology-Iinfused (TI) and Control Group (CG) Post-Assessment Surveys

TI (n=24)		CG (n=26)				
Item	Mean	SD	Range	Mean	SD	Range
Level of expertise using:						
Macintosh	7.1	1.1	5.0	6.5	1.7	6.0
Apple IIe	5.0	1.6	7.0	4.8	1.7	7.0
IBM/clones	3.8	2.0	7.0	3.8	1.9	5.0
Level of confidence using microcomputers for instruction	6.5	1.4	6.0	6.3	1.7	6.0
Likelihood of using microcomputers in field experience	7.3	1.8	5.0	6.5	2.5	7.0

language arts course.

The results of the post test surveys are presented in Tables 2 and 3.

As indicated in Table 2, at the end of the class, both groups felt more expert in their use of Macintosh than either Apple II or IBM computers. Both sections continued to report mid-range confidence in their abilities to teach with microcomputers. The TI section appeared to report a higher likelihood of using computers in the field experience than the CG section although T-tests showed no significant differences between sections.

The TI section was asked to respond to a number of items dealing with classroom activities in which technology was infused into their section. A nine-point Likert scale was used. Items were ranked from 1 (not helpful) to 9 (helpful) on this instrument. The results of this survey are presented in Table 3.

As illustrated in Table 3, attendance at a technology conference had the most effect as reported by the students in the section. Other items ranked relatively high were completing the electronic journal and instruction from the required computer course. The items which had relatively little effect were tutoring children during the week, the worksheet assignment, and support from the cooperating teacher.

In order to assess the amount of gain on the survey questions asked pre and post, the data for each section were compared. These data are presented in Tables 4 and 5.

Table 3
Means and Standard Deviations for Technology-Infused (TI) Activity Surveys

		TI (n=24)		
Item	Mean	SD	Range	Rank
How helpful were each of the following in increasing your expertise in using computers:				
1. Electronic journal	6.7	1.1	5.0	2
2.. Tutoring children on Mondays	4.4	1.9	6.0	9
3. Completing book abstracts	6.3	1.2	5.0	5
4. Attending technology conference	6.8	1.7	7.0	1
5. Worksheet assignment	5.3	2.3	7.0	8
6. Access to Reading Center Computer Lab	5.5	2.2	8.0	6
7. Assistance and instruction provided by team	6.4	1.5	6.0	3
8. Support from cooperating teacher	5.4	2.5	8.0	7
9. Notes/instruction in required course	6.4	1.7	5.0	4

Table 4
Pre and Post Means and Standard Deviations for Technology-Infused (TI) Section Assessment Surveys

	Pre (n=24)		Post (n=24)			
Items	Mean	SD	Mean	SD	*t*	*p*-value
Level of expertise using:						
Macintosh	5.7	2.8	7.1	1.1	3.51	.002*
Apple IIe	3.9	2.3	5.0	1.6	2.92	.008*
IBM/clones	2.8	1.8	3.8	2.0	3.94	.001*
Level of confidence using microcomputers for instruction	5.1	2.1	6.5	1.4	5.27	.000**

* $p<.05$ ** $p<.001$

Table 5
Pre and Post Means and Standard Deviations for Control Group (CG) Section Assessment Surveys

	Pre (n=26)		Post (n=26)			
Items	Mean	SD	Mean	SD	*t*	*p*-value
Level of expertise using:						
Macintosh	5.9	2.0	6.5	1.7	2.52	.019*
Apple IIe	4.2	1.8	4.8	1.7	2.42	.024*
IBM/clones	3.7	1.7	3.8	1.9	.32	.753
Level of confidence using microcomputers for instruction	5.9	1.3	6.3	1.7	2.3	.030*

* $p<.05$

As seen in the Tables 4 and 5, both sections (TI and CG) showed significant ($p<.05$) gains in the level of expertise reported on the Macintosh, Apple IIe, and in regard to their overall confidence in using computers for instruction. The TI section also gained significantly in their level of expertise in using IBM/clones.

Discussion

The purpose of the present study was to develop a model for the infusion of computer technology into an integrated reading/language arts methods course. Accordingly, activities were developed to provide specific experiences for the students in the technology-infused (TI) section. A nine-point Likert scale was used to elicit perceptions of individuals' expertise using the Macintosh, Apple IIe, and IBM/Clone computers. Using the same format, students were also asked to indicate their level of confidence in using computers for instruction. The same questions were asked of a second methods section which acted as a control group (CG). No particular emphasis was given to computers in this section.

In general, the results were disappointing. Although the TI students gained significantly in their reported level of expertise, the means for this section were not significantly different from the means in the CG section. In retrospect, there are two main reasons to account for this finding. First, it is possible that the CG section received computer instruction and applications in methods classes other than reading/language arts. Second, it is possible that the survey questions lack the specificity essential for clear results. Thus, it is not possible to say that the CG had a complete omission of computer technology.

Given the activities which were completed by the TI section, it was interesting to note that attendance at a professional technology conference rated the highest of all activities completed, even over activities in which computers were directly used. At this conference, students were able to hear other teachers discuss the use of technology and to preview current hardware and software. This seems to be an important finding given the concern for use of class time in university methods courses.

Finally, what could be done differently? Obviously a more detailed survey would provide further insights into the changes being experienced. Also multiple sections rather than just a pair should be surveyed (Beever, 1981). Perhaps a detailed analysis of research methodology along with a revision of instrumentation could strengthen the design and implementation of a new study on the effectiveness of a technology-infused curriculum.

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Hypertext portfolios: A new approach to teaching reading diagnosis

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Authors of diagnostic reading texts have long recognized the need to demonstrate for students how concepts, principles, and theories apply to the circumstances of actual children. A few have made extensive case study the organizing theme of their books, but most have sought to intermingle content presentation with brief examples of applications based on real or hypothetical children. Neither approach is wholly satisfactory in reconciling two traditional approaches to instruction. In concept-based learning, content is central and application is assumed to develop deductively—from the ideas to cases. In case-based learning, students infer general ideas inductively from their study of cases. The ancient disciplines of law and medicine differ sharply on which is the more effective approach, but no one disagrees that in some way, at some point, cases and content must be integrated if competent practitioners are to result.

Spiro (1991) described an attempt to merge the two approaches by establishing a computerized network of information within which medical students could go from textbook to cases and back again as they saw the need to do so. This application of hypertext, a nonlinear representation of text that facilitates digression to other sources, was the basis of the present project. Portions of a diagnostic text were linked by means of HyperCard to an extensive set of data for a single child—in effect, an electronic portfolio. Graduate students in two reading diagnosis courses are now being immersed in the system and are being given the freedom to examine, in any manner they wish, both the student data and the textbook passages. Our eventual goal is to determine whether their understanding of diagnostic principles and thinking improves as a result of the experience.

The Nature of Hypertext

It is probably natural to think of text in linear terms, as having a beginning, middle, and end. A reader progresses through it along a path that very much resembles a straight line. There may be occasional departures from this path, but the good reader is assumed to minimize them. The notion of hypertext entails a potential network of such departures and, quite unconventionally, assumes that readers will and should use them.

This difference is sometimes couched in political terms. Linear text may be seen to constrain the reader's choices and dictate a course plotted by the author, who prescribes what the reader needs to know at each successive point. Hypertext, on the other hand, may be viewed as empowering the reader to explore a network of information in order to satisfy personal goals and interests. Ironically, it also permits the reader to hold to the conventional, linear course, but only as a matter of individual choice.

The notion of hypertext does not require computerization. At its simplest level, a reader who has available ordinary textual aids, such as footnotes, a glossary, embedded charts, figures, and the like, is positioned to become a hypertext user. Even the reader who lacks these devices has the potential to plunge into hypertext by means of outside sources, including reference materials, books actually cited in the original text, and other sources indirectly suggested.

Computerization facilitates sojourns into hypertext by making it quicker and more convenient (Blanchard & Rottenberg, 1990). The speed at which a learner can explore connections in the process of constructing knowledge is indeed one of the most powerful attributes of hypertext (Balajthy, 1989). Another is the notion that learning occurs best when the learner is free to interact and "play" with concepts and ideas in a manner that is self-managed (Nelson, 1988; Spiro, 1991).

Adapting Hypertext to the Diagnosis Classroom

Computer applications in reading diagnosis have been varied (McKenna, 1991). They include eye movement measurement and text presentation control (McConkie & Zola, 1987), expert systems (McKenna, 1986, 1987), test administration (Blanchard, 1985), and strategies for contrasting clinician judgments (Vinsonhaler, Weinshank, Wagner, & Polin, 1987). To our knowledge, a hypertext application is novel and accordingly raised a number of questions in how to proceed.

1. How much of the text should be included? Most conceptualizations of hypertext entail a complete representation of the linear text as a baseline from which to digress. We rejected this course for several reasons. First, memory limitations make this goal unattainable with the hardware that is likely to be available in college labs (Balajthy, 1989). Second, reading speed is slowed considerably by most computer presentations of text. Third, computer access time would have prohibited the sort of in-depth reading that the availability of an extensive textbook implies. Finally, complete text representation would have been more defensible had students been studying entirely on their own. They were not. Lecture settings served to introduce content that was reinforced and elaborated by reading assignments undertaken in the conventional manner. The hypertext setting allowed students to reaccess relevant portions of the text, portions previously covered from the perspective of concept-based learning. Now, however, their primary goal was to examine diagnostic data, using the textbook excerpts to remind and clarify.
2. What data should be included? An extensive textbook on the subject of reading diagnosis typically contains hundreds of references to tests and other data sources. An ideal case study networked to such a text would present corresponding results for the same child. Actually gathering such data would obviously raise serious ethical questions about overtesting, however. Moreover, such a sweeping regimen of testing would involve pupil growth in the time required to complete it and would almost surely reflect instructional effects of the assessment itself. For all of these reasons, a far more modest plan was enacted. Data were assembled selectively, using the text used in the course (Lipson & Wixson, 1991) as a guide. Numerous informal instruments included in the text (child interviews, teacher checklists, etc.) were administered along with a limited number of commercial instruments. The most time-intensive of these was the Qualitative Reading Inventory (Leslie & Caldwell, 1990), an Informal Reading Inventory (IRI) discussed extensively in the text. Thus, student data were gathered both selectively according to its probable instructional value and text-specifically so that linkages between text and results would be clear-cut.

   Two useful features of the system converted it from hypertext, in the strict sense of the term, to hypermedia. One was the possibility of recreating oral reading selections that had been digitized from tapes recorded during testing. A student could listen to a passage while examining its coded form on the screen. The other was the capacity to scan and store student writing samples. Visual aspects of student-generated documents (handwriting, spatial arrangement, etc.) were thus captured for inspection.
3. How should the system be organized? One of the formidable aspects of hypertext is the potential to overwhelm. The user might actually become "lost" in sophisticated systems marked by frequent branching and a multiplicity of sources (Yankelovich, Meyrowitz, & van Dam, 1985). For this reason, a simple framework was used. A menu of assessment areas served as a starting point and permitted branching in two directions: to a textbook excerpt or to case data. We acknowledge that far more extensive systems are possible, involving test reviews, articles, data for other children, and so forth. Building such elaborate systems has intriguing potential, but must be approached with caution. Further research should compare the effectiveness of extensive systems with more simplified versions.
4. How should students be introduced to the system? Because concept-based learning had preceded exposure to hypertext, our introduction to the system was not lengthy. First, the nature of hypertext was explained and its purposes and potential discussed. Second, group discussion was used to facilitate the development of individual goals. Assessment issues were reviewed, a few possibilities suggested by the professor, and others

generated by students. Each student was encouraged to jot down personal objectives, however, and to view the discussion as merely suggestive. Finally, students were introduced to the actual HyperCard system in a networked laboratory setting.

Future Directions

Data are now being collected concerning the effects of the hypertext system on the diagnostic ability of graduate students. Analysis should provide useful ideas for revising how the system is organized, what it contains, and how it can best be utilized.

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The Earthquake Club: A model for integrating technology across the curriculum

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Introduction

For the last three years professors and students at the University of Northern Colorado (UNC) have been continually redesigning Classroom Educational Technology, an upper division course required of all Professional Teacher Education (PTE) students. The course, better known as ET 401, has undergone a number of changes, most of them aimed at having students engage in meaningful hands-on experiences with various technologies. One issue that emerged from the various iterations of ET 401 was the need to provide students with not only the basic skills necessary to incorporate technology into their professional experiences, but also to provide a model for integrating technology across the curriculum.

During the summer semester, 1992, a group of educational technology graduate students and instructors designed a special section of ET 401 aimed at providing PTE students with a model of how they could incorporate various technologies into their teaching. This paper describes the project, known as the Earthquake Club, and summarizes the interview data that was collected at its conclusion.

"Hands-On Training" Versus "Learning About"

Collis (1988) describes a situation that plagues many introductory educational technology classes. Often computer literacy is reduced to "information students could know about computers, including various names and dates supposedly pertinent to the history of computers, and vocabulary associated with the computer itself" (p. 8). This theme could apply to more than just computer technologies. Students are taught *about* technologies but are given few opportunities to *practice* using them. The Office of Technology Assessment (OTA) advocates an appropriate balance between demonstrations and practice sessions (Scrogan, 1989). Other OTA suggestions include emphasizing hands-on training, building a "tool focus so that teachers can become personally empowered by technology use, and helping teachers catch the vision and develop approaches to integrating technologies within their content areas" (Scrogan, 1989, p. 83). These suggestions and premises, along with the desire to provide students with a model of technology integration, formed the foundation for the Earthquake Club project.

Design of the Project

During the summer semester, 1992, students enrolled in a section of ET 401, an undergraduate course in classroom educational technology, and ET 610, a graduate course in educational materials production and took part in the Earthquake Club Project. The undergraduate course was organized around the theme of earthquakes. This theme was chosen arbitrarily in order to provide students with a model of how technology could be incorporated across the curriculum. The twenty-five students in the ET 401 class were divided into five groups of five students each. Each group was assigned the following:

a. a sub-topic related to the main topic of earthquakes
b. graduate student mentors from the ET 610 class
c. a technology

Group 1 was assigned Mechanics of Earthquake Faults as its topic and hypermedia as its technology; Group 2 was assigned Sociological Implications of Earthquakes and Desktop Publishing; Group 3—Plate Tectonics and video; Group 4—Famous Earthquakes in US. History, desktop publishing; Group 5—Geographical Distribution of Earthquake Faults in the U.S., hypermedia.

Since the two graduate and undergraduate educational technology courses met at the same time on the same days, class time could be used for the small group work. The first task was for each group to research its sub-topic. Students used a variety of resources including on-line and CD-ROM databases in order to gather information about their topics. After being shown many examples of well designed projects that utilized their assigned technology, each group engaged in its own project design under the watchful eyes of the graduate student mentors.

Group 1 chose to build a Toolbook project that showed cross sections of various types of earthquake faults complete with hotwords and animation. Group 2 used Aldus Pagemaker to produce On Shaky Ground: A Sociological Newsletter. These students scanned in images of earthquake destruction and wrote articles like "Psychological Problems from Mexico City Quake: Earthquake Puts Strain on Social Services," and "Are You Prepared?" Students in Group 3 used a sophisticated video editing system and computerized digital special effects to produce "Whole Lotta Shakin' Goin' On," a ten minute instructional video about plate tectonics. Group 4's project was a newsletter entitled As the World Quakes: Infamous United States Earthquakes. Like Group 2, this project exploited the powerful graphics and desktop publishing capabilities of Aldus Pagemaker. Group 5 used Toolbook to construct a map of the United States that was divided up into several regions. The user navigated through this hypermedia project by clicking the mouse on the region of interest. Overall, the relative sophistication of the projects was impressive, especially considering the fact that many of the twenty-five students in ET 401 had very limited, if any, experience with microcomputers.

A Shaky Summer

Seven days after students began working on their projects, a powerful earthquake rocked Southern California. On June 28 at 5 AM an earthquake measuring 7.4 on the Richter Scale centered near Yucca Valley provided the Earthquake Club students with not only a wealth of data and current examples that they could use in their projects, but a sense of purpose for what they were doing. The quake made the front page of Group 4's newsletter, and network news coverage of the earthquake provided footage for Group 3's video. During follow-up interviews, students in the ET 401 class reported that they looked at news coverage and newspaper accounts of the California quake differently—more critically and with a special perspective depending upon the group in which they were working.

The Model

The main purpose for conducting this special project was to provide future teachers with a model that they could adapt to their own curricular areas and to emphasize how projects like this help reinforce skills from many curricular areas. For example, students in the desktop publishing groups used English and journalism skills when preparing their articles. They also demonstrated their understanding of various design principles when laying out their newsletters. Students in the hypermedia groups learned about geography, chemistry and physics while looking at how earthquake faults worked.

The inclusion of groups that looked at *historical* and *sociological* perspectives of earthquakes was an intentional move to demonstrate that the study of earthquakes involved more than geology. This provided students with a cross-curricular model where history and sociology were studied along with plate tectonics and other geologic topics. The final result of the five groups' projects was a student produced knowledge base on various aspects of earthquakes. In place of a final exam, students made formal presentations of their projects which was followed by an informal question and answer session.

Interviews

Formal semi-structured group interviews were conducted at the conclusion of the semester. The purpose of the interviews was to determine what the students had learned from the Earthquake Club project, and to make decisions about whether to continue the project on a larger scale in future ET 401 classes. Researchers also wanted to gather data about student attitudes toward the design of the class and their perceptions of its relative usefulness in their professional careers. Several major issues emerged from the interview data.

One issue that was mentioned by several participants concerned access to technologies. Professional Teacher Education (PTE) students hoped that they would have access to high powered computers and appropriate software in order to have their students engage in similar activities. Others pointed out that, while Toolbook and Aldus Pagemaker might not be readily available, other less powerful but equally useful programs may be. They commented that the model presented was not hardware and software specific and that it left room for creative uses of other computer and non-computer technologies. Several students said that the Earthquake Club was a great confidence builder. Students who reported themselves as technophobic before they took the class said that they would be willing to take risks with other technologies in the future. Several students reported that working with a mentor was a key ingredient in minimizing the intimidation factor.

Students reported that they appreciated the fact that this course did more than just scratch the surface of how technology could be incorporated into teaching. They felt that they were very competent in at least one technology—the one that was assigned to their small group. They felt that this approach was superior to learning about many different technologies but not learning how to effectively use them in teaching. In other words, the PTE students appreciated the in-depth hands-on approach to learning new technologies. Depth was preferred over breadth.

As a result of participating in the Earthquake Club, several PTE students said that they would become advocates for technology in their schools. One respondent said that programs like Hypercard and Toolbook could be used in virtually any subject area and in almost any grade level. Students in the desktop publishing group said that they were surprised how easy it was to manipulate the software. Again, they saw much potential of desktop publishing in many different content areas and grade levels.

Implications and Conclusions

Several factors contributed to the relative success of the Earthquake Club. First, graduate student mentors were available to work with the undergraduate PTE students on their group projects. Second, students had access to powerful state-of-the-art hardware and software. Third, students were given ample class time to design and produce their projects. Finally, the class size of twenty five was manageable—atypical of most ET 401 classes. These conditions are rare. During a typical fall or spring semester, there are more than 200 students enrolled in ET 401 classes. This puts incredible strain on the available technology and human resources. The challenge for course designers is to adapt what has been learned from the Earthquake Club project to larger classes with fewer mentors and less class time available for students to work on projects.

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INSTRUCTIONAL TECHOLOGY

In 1993, few teacher educators would debate the necessity of preservice and inservice teachers becoming comfortable and competent with a variety of educational computing tools, terms, and technologies. A decade (and more) earlier, this was commonly called *computer literacy,* and in the intervening years, most schools of education and school districts have created and implemented plans for helping teachers to become "computer literate." One of the most popular contexts in which teachers encountered educational computing was (and still is) the undergraduate or graduate instructional media or educational computing class, required in many states and teacher certification programs. The papers in this section address the planning, implementation, and outcomes of such courses.

Literacy is generally regarded as referring to reading, writing, and computation. Earlier notions defined it as being able to read a short passage and correctly answer questions pertaining to it (Gove, 1986). The exact definition of "computer literacy" has not been agreed upon, as it is context-dependent and changes as rapidly as hardware and software evolve. Indeed, many teacher educators now refrain from using the term, since "literacy" implies a broader and deeper notion than a set of skills associated with using machines. (For example, do we speak about "automobile literacy" or being able to drive? Do we call being able to tape a movie for later viewing "VCR literacy?") It seems that as teacher educators have tackled the challenge of preparing teachers to effectively use and infuse use of educational computing tools into their teaching, the emphasis has moved away from the machine and toward the methods for use.

To illustrate this trend, please consider the following. In 1980, the Association of Computing Machinery published the following definition of "computer literacy" (cited in Geisert & Futrell, 1984).

Computer literacy includes the ability to:

1. Read and write simple computer programs
2. Use educational computer programs and documentation
3. Use computer hardware terminology
4. Recognize the limits of solving educational problems using the computer
5. Locate information on computing in education
6. Discuss the historical development of computer technology for education
7. Discuss the moral and human impact issues relating to societal and educational use of computers

Three years later, the *State Plan for Computer Utilization in North Carolina Public Schools* defined the following "essential elements...in a computer literacy program for teachers" (cited in Geisert & Futrell, 1984).

1. Overcoming negative attitudes or fears
2. Familiarizing users with the basic components of a

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microcomputer

3. Describing what computers and computer programs can and cannot do
4. Introducing computer programming
5. Identifying sources of information about computers and software
6. Discussing the impact of computers on society

Note that in just three years, the definition of "computer literacy" for teachers appears to have shifted. There is a de-emphasis upon programming and technical specifics, and increasing emphasis upon the development of positive attitudes toward use of computer-related technology. Note also that statements of learning goals have become more general in scope and semantics. This last point is well illustrated in the current Texas Education Agency's statewide requirements for computer competency for teacher certification candidates (TEA, 1988):

Computer competency for teacher certification includes:

1. Social, ethical, and educational implications of computer use,
2. Use in delivery of instruction,
3. Use as a productivity tool,
4. Use in teaching problem solving,
5. Selection of appropriate courseware and systems,
6. Fundamentals of information processing. (Title 19, Part II, Chapter 137, Subchapter M, page 2)

As indicated by the example above, more recent guidelines for educational computing preparation emphasize the *uses* of computer-related media, rather than their history and technical specifications. This is further demonstrated in recently-adopted NCATE Foundations Standards for professional studies in education (ISTE, 1992), which emphasize use of broad and diverse classes of educational technologies in the design of instruction and the facilitation of ongoing learning for both students and teachers. Other recent publications about technology use in schools emphasize the synergistic relationships between the adoption of technological innovations and educational restructuring (i.e., Newman, 1992).

The papers in this section reflect current thinking about educational computing competencies as it is demonstrated through the design and delivery of undergraduate and graduate education courses. Thompson, Schmidt & Topp describe a comprehensive program at Iowa State University that makes computer-related experiences available to students through foundations courses, methods courses, field experiences, and an optional educational computing minor. It is interesting to note that their plan for *students* includes the mentoring of *faculty* in use of computer-related technologies. Jan Koppelman shows how computer-related experiences can be successfully integrated into a "once-typical" educational media course. The resulting course structure and teaching/learning methods are anything but conventional. Brownell, Brownell & Zirkler show how attitudes about computer use significantly change as a result of students' participation in required educational computing courses, and have brought out an interesting point about students' feelings about learning to write computer programs. Rebecca Brent provides many helpful ideas about how to use writing assignments to help students to discover, organize, clarify, and summarize what they are learning while enrolled in educational computing courses. Julie Bao shares how she was able to individualize the content and process of an educational computing class according to her students' needs and preferences.

We are indebted to these teacher educators for sharing their ideas, techniques, and results with us. It is my hope that *Annual* readers will take full advantage of the "professional services" offered by these authors by reading and reflecting upon the papers in this section.

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The development and implementation of an instructional computing program for preservice teachers

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The need for quality experiences for undergraduate students in the area of instructional computing is well documented in the literature (Bitter & Yohe, 1989; Bruder, 1991; Strudler, 1991; Walker, Keepes, & Chang, 1992; Wetzel, 1992). If new teachers are to use technology effectively with their students, they must have appropriate experiences and instruction throughout their preservice program. In this paper, a model program integrating technology into teacher education will be described.

During the past ten years, the College of Education at Iowa State University has developed a technology program for undergraduate teacher education students that is designed to make technology an integral part of the teaching and learning environment. The program, designed to model the applications of technology teachers will be using with their own students, includes the following three components:

1. a course in computer-related technology
2. computer-related technology experiences in foundations, methods and field experience classes
3. an optional minor in educational computing that includes eighteen credits of coursework in computer-related technology topics.

The first two components of the program are part of the curriculum for all teacher education students. The third component is designed for students who wish to specialize in the area of educational technology.

Accessibility to hardware and software is an important factor to consider when designing and implementing an instructional computer program. The hardware and software used for all three components of the Iowa State technology program is located in five computer laboratories, a model technology classroom, and a model mathematics/science technology classroom in the College of Education. Other computers are available on portable carts for use in classrooms and in faculty offices. A software collection of approximately 1,000 titles is also available for faculty and student use.

Computer-Related Technology Course

The three (3) credit computer-related technology course is based in the belief that preservice teachers can learn to use various computer tools to amplify cognition. This semester-long course has been taught and continually developed over the past ten years. Topics for the class include word processing, database management, spreadsheets, graphics programs, Logo programming, hypermedia, problem solving, telecommunications and desktop publishing. The text for the course, authored by the instructor and graduate students in instructional computing, is now in its fourth edition. The text reflects the tool-based and hands-on approach of the class.

A variety of innovative teaching strategies that incorporate technology are modeled for the students during lecture and laboratory experiences. Students are required to complete relevant weekly projects that develop personal computer skills and promote positive attitudes toward technology. During laboratory time, emphasis is on student participation that introduces hands-on activities that could easily be incorporated into any classroom. For example, students are required to design a database for any curriculum topic, then design questions that would supplement the database in order to develop information handling skills. In many cases, students are able to apply this knowledge of technology within other courses and field experience opportunities.

Technology Integration Throughout the Teacher Education Program

One of the best opportunities for introducing the uses of technology in an instructional setting is the integration of computers in the methods courses (Niess, 1990). Technology integration into foundations courses, methods courses and field experiences is a continuing area of emphasis in the teacher education program at Iowa State.

In order to integrate technology use into methods and foundation courses, computer-using faculty members have become mentors for interested colleagues, helping them to develop technology-related activities for specific courses. This collaborative effort begins with the mentor modeling effective teaching strategies using technology in the classroom. Then, the mentor slowly phases out of the instructional process while the instructor gradually begins to integrate technology into his/her own course with continued support from the mentor. Support is also given in the selection of software and the set-up of hardware.

Some activities that have emerged from this mentoring process include the development of reading-writing activities that incorporate technology, the use of telecommunications as a vehicle to communicate with elementary students during the writing process, the participation of students in simulations, and the use of commercial software for tutoring elementary students. The next step in this process will be the involvement of more faculty members who are interested in integrating technology into their courses.

An example of how technology is being used to support field experiences and decrease student isolation within the teacher education program is the Electronic Educational Exchange (EEE) project. The EEE is an electronic bulletin board designed to enhance communication among school administrators, classroom teachers, and selected students throughout Iowa, as well as Iowa State's preservice teachers, faculty and graduate students. The EEE relays public and private messages among users and promotes open discussions on a variety of special topics. Conference topics are changed each semester, but public electronic mail facilities are always available for any questions, requests, or ideas a user wishes to share with other EEE users.

Future plans for the integration of technology throughout the teacher education program will continue to evolve as innovative technology uses are designed by faculty and students. A new model technology teaching classroom, designed for mathematics and science methods classes and funded by the National Science Foundation, is currently being used for the first time. The classroom, containing seven computer workstations with videodisc players, CD ROM players, and *XAP Shot* cameras enables preservice teachers to use technology for "hands-on" mathematics and science experiences. As the faculty and students become more comfortable using technology, this new facility will be widely utilized throughout the college.

Educational Computing Minor

An educational computing minor has been offered for preservice teachers who are interested in specializing in the use of technology in schools. Students who receive the educational computing minor are prepared to meet the challenges of using technology in future classroom settings. This minor combines eighteen credits of coursework in technology, computer science and psychology.

The technology courses included in the minor are the computer-related technology course previously described, a classroom applications computer course and an instructional design course for the development of computer-assisted instruction (CAI). Each course builds upon the knowledge level of the previous course and each emphasizes the integration of various computer-related technologies into the curriculum.

In the classroom applications course, students are required to creatively integrate computer-related technologies into the K-12 curriculum. After small- and large-group discussions, role playing situations, and hands-on activities using technology, students design classroom applications for the effective use of technology. In addition to traditional computer topics, school restructuring, hardware troubleshooting, telecommunicating and networking are discussed. Students are asked to complete a variety of assignments in which they take the perspective of a specific grade-level learner or teacher.

Application of instructional development principles and learning theory for developing computer based instructional systems are included in the third computer-related technology course offered in the minor. Students gain familiarity with a few programming languages and authoring systems while designing instructional computer-based scenarios and lessons. One project in this course allows preservice teachers to fieldtest their computer-based lessons and instructional methods with students in schools.

A specific field experience is offered that requires the use of technology by preservice teachers in schools. For one semester hour of credit, students spend a minimum of twenty-four hours in classrooms or computer laboratories. This field experience includes observing computer-using teachers, assisting teachers with using technology, teaching curriculum topics using technology, and facilitating teacher and administrative inservice programs.

Students enrolled in the educational computing minor have become excellent role models in using technology for other students and faculty in other courses. In addition to providing this type of informal support, most of the students taking the educational computing minor also work as consultants in the college computer laboratories.

Conclusion

This paper has described a technology program for preservice teachers that makes technology an integral part of the teaching and learning environment throughout the college. The three major components of the program are a course in computer-related technology, computer-related technology experiences in foundations courses, methods courses and field experiences, and an optional educational computing minor. Although the computer education program at Iowa State University is continually evolving, it is designed to empower students with the knowledge and attitudes necessary to use technology as a tool for their own learning and teaching.

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An educational media course: Merging theory, technique, and application

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Viterbo College is a small, private liberal arts college set in La Crosse, Wisconsin along the Mississippi river. The college is noted for its programs in the fine arts and in nursing, and the teacher education program has experienced some recent growth. Viterbo, like many other teacher education institutions, offers an introductory course in educational media for preservice teachers, as well as other interested students. The course is required for elementary and secondary education majors, and is recommended for some other majors as well. Students normally enroll in the educational media course as juniors, having completed several other education courses including Introduction to Education, Educational Psychology, and possibly some methods courses.

The purpose of the typical educational media course is to introduce techniques for development and production of instructional materials, and to give the students experience in operating audiovisual equipment. Although our students do have reasonable access to computers, their exposure and access to technology and technological applications is rather limited. However, given this limitation, the course that we have developed for Viterbo students features a hands-on approach that goes beyond simple production techniques. Our students are challenged to apply the educational principles they have already learned in other courses in the development, analysis, evaluation and implementation of projects they complete for this class. Students quickly discover that this is not a course in "cut-and-paste" or electronics, but an integrated experience that allows them to creatively apply the skills and knowledge they acquire in this and other courses in developing materials for real-life applications.

My own exposure to educational media as an undergraduate consisted of one class period in a semester-long "general methods of teaching" course where the university's A-V technician demonstrated how to load projectors and show films. In talking with others who came through teacher education programs at about the same time, it appears that my experience was typical. Unfortunately, when I got into my own classroom, the equipment with which I was confronted only vaguely resembled what had been demonstrated over a year earlier. I didn't schedule many films after my initial experience.

Other courses in educational media may focus on training students in production techniques. Here the emphasis seems to be on technique, often without much attention to practical applications for the resultant products. Students learn good production skills, but the end products can be of questionable educational value or may not successfully communicate the concept to the target audience.

When I first began teaching the educational media class at Viterbo nearly 15 years ago, I structured the class as a blend of instruction in equipment operation and production techniques. This proved to provide the students with adequate experiences in the aspects of educational media they were likely to encounter as classroom teachers. I found that students easily mastered the production skills, and most successfully struggled through the equipment proficiency assignments without too much fear. However, the students consistently exhibited the most difficulty with generating ideas for the content of whatever project they decided to produce.

I began to tinker with course structure and material in an attempt to ease their struggle with content. What evolved is a course structure which utilizes the concept of a student selected "focus topic" for production projects. The Focus Topic enhances students' understanding of learning theory and principles of visual communication through practical application. My goal was to help students expand the hands-on production experience and to develop a unified collection of materials that are educationally sound and communicate successfully while students work through a carefully designed procedural framework. As this integrated approach has evolved, I have observed a significant improvement in student work. Other faculty members in related courses in which students develop presentation materials have noted similar improvement.

At the beginning of the course the students are asked to identify and define their Focus Topic. This topic then determines the content of all production projects they complete throughout the course. In selecting their topic students are encouraged to look beyond their majors and a conventional classroom context. They may select a topic about which they already have some knowledge and which is of genuine interest to them. They may consider topics that relate to hobbies, special interests, or even something about which they would like to discover more.

The Focus Topics range from the conventional to the bizarre. Initially topics selected tended to be very traditional and not very specific: "Farm Animals, "Colors", "The Five Food Groups", etc. After several semesters of similar offerings, I attempted to stimulate creativity through an exercise which asked students to create a list of their favorite foods, music, movies, pasttimes, people, events, issues, etc., and develop ideas for Focus Topics from that list. This seemed to improve the range of topics. In addition I developed a list of "Taboo Topics" (including such topics as "Farm Animals", "Colors", and "The Five Food Groups") that I asked students to avoid. Since the "Taboo" list has been employed, I have noted a significant improvement in the variety of topics. Some of the more unusual topics have included: "The Barouquen Stage - Behind the Scenes of an Authentic Barouque Opera Production", "Body Building for Women", "Competitive Ballroom Dancing", "The Advantages of Birkenstocks", "The Beatles", "Life in Hell—the College Dorm", and "Pigeon Racing".

Each student produces a detailed topic proposal document that identifies and describes their topic in a very specific way. The students must include details about the intended target audience, the situation in which the topic is likely to be presented (not necessarily a classroom or an educational setting), the primary concepts to be presented, some possible learning activities or techniques that might be employed, and ideas for projects they might produce and incorporate in presenting the topic. Students also develop an annotated bibliography of existing resources (print and non-print) that will provide additional information to them as well as to their target audience.

As students develop the topic proposal document, lectures and classroom activities explore and review learning theories, the use of learning objectives, principles of visual communication, as well as some simple computer applications. Once the topic proposals are finalized, students begin planning for assignments and the production projects they choose to develop. The course grade is determined by the number of points earned, so students select and do as many assignments or production projects as they need to earn the requisite points for the grades they desire. The required assignments are the topic proposal, an equipment operation practicum, and a script for either a slide show or a videotape. All other assignments and production projects are optional; however, students must complete at least one optional production project to receive a passing grade.

Assignment options include an ERIC search and abstracts, a tour of an IMC or TV production studio, a visual analysis paper in which students examine a piece of visual communication (often a magazine ad) and analyze how the elements of art and principles of design have been applied, and software demonstration and reviews. Production project options include various displays, transparencies, slide shows, and video projects. The variety of assignment and project options allows students to explore different types of media, experiment with production, and select projects that are best suited for their topics and interests.

Although students are not required to produce a complete project for each of the types of production project options, they do get some hands-on experience in each general type of media. A "sample" mini-production experience is included as well as a demonstration of various production techniques during each lecture. For example, during the lecture/presentation on displays, each student is given an opportunity to drymount and laminate a small sample picture. This immediate hands-on experience is only possible if class sections are kept small, of course.

Students receive an assignment packet at the beginning of the semester with explicit details for the requirements for each assignment or project option and the criterion and point value for each. Students may also propose alternative projects. Students receive full point value for each project as long as the criterion is met and the quality is acceptable. Bonus points are also awarded for projects that are clearly exceptional. I have found that awarding full credit for acceptable projects eliminates students' concerns that the evaluation is too "picky" or that expectations are too high. This practice also seems to encourage the students to think creatively and to experiment. When the fear of "losing points" for minor flaws is removed, students seem to be less wary of attempting projects they might not otherwise consider.

Points earned from assignments and production projects can also be supplemented with "extra credit" points earned by assisting other students' productions (acting in a video, reading a script, modeling for a slide shoot, etc.). The students are encouraged to work for these extra credit points because I have found that this gives them additional exposure to production processes and helps build their confidence to try similar projects on their own. Student comments indicate that working as a production assistant is a very valuable experience. One student commented that as she read the script for her classmate's project for an audio recording, ideas for her own project began to "pop" into her head. She indicated that the act of participating in someone else's creative process stimulated her own creativity.

The closure activity for the course is a presentation of the topic as a "mini-lesson" or presentation in which the students use the projects they have produced. Because the students have selected their topic at the beginning of the semester, and all of the projects for the class have been developed to teach or present some concept within the context of that topic, the mini-lesson falls easily into place. The primary task is to develop an appropriate opening, closing and transitions to set the stage for presenting the media. The focus of the evaluation is on total communication, including presentation and communication skills and skill in using both the hardware and software in the presentation. Students make the presentation twice. The first time it is presented to a small group of two or three other students and videotaped for peer review and self review. The students also make the presentation to the entire class and the instructor, thus giving them an opportunity to see what ideas have been developed by others in the class.

Until the "topic focus" course model was implemented, many students spent considerable time simply trying to identify the subject matter and concepts for a project. In addition, students were less likely to think about how they might actually employ the end product, and frequently failed to apply sound design and teaching principles because they were distracted by developing the content or were focussed upon simply mastering the production techniques.

When the content for projects has already been determined, application of visual communication concepts and learning theory is facilitated as students develop necessary production skills. Students leave the course with a unified collection of instructional materials on a topic of interest to them. In the process of creating these materials, they have developed skills in the application of learning theory and visual communication techniques that they can use when developing materials for future use in instructional settings.

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Two studies: Attitude change during a required computer education course for preservice teachers

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Two studies examined attitude change in preservice teachers during a computer education course. In both studies, attitude was measured in relation to computers in 4 areas: usefulness, liking, anxiety and programming. Students were administered the attitude measure at the beginning and end of the course and were also asked to report their perceived level of expertise with computers at the beginning and end of the course in both studies. Cronbach's alpha was used to assess the reliability of the attitude instrument in both studies. In the first study, Repeated-measures ANOVA's were used to test for pre- and post-test changes in attitude, change in perceived level of expertise regarding computers, and for main effect interaction with instructor. Repeated-measures ANOVA's were used in the second study to test for pre- and post-test change in attitude, change in perceived level of expertise regarding computers, and for main effect interactions with GPA, pre-test perceived level of expertise with computers, and year in school.

The first study involved subjects in two sections of the course ($n = 18$ and $n = 28$). Each was taught by a different instructor. The study took place as course content was being standardized across instructors. Participants in the course were elementary education majors.

The Cronbach's Alpha for the pre-test in the first study was .89 and for the post-test was .88. Significant differences ($p < .001$) between pre- and post-tests were found on the usefulness, liking, and anxiety subscales of the attitude instrument with an indication of a positive shift in attitude in each area. A significant difference ($p < .05$) was found on the programming subscale, with an indication of a negative shift in attitude. A significant difference ($p < .001$) was also found in participants' perception of their level of expertise with computers, indicating an increase in their perceived level of expertise. No interaction was found between any attitude measure and instructor.

In the second study ($n = 130$) the course format was changed. In this study the course was taught by two instructors in a lecture/lab format. Participants were elementary education majors. The Cronbach's Alpha on the pre-test for this group was .91 and on the post-test was .90. In this study, to investigate possible main effect interactions with pre-test perceived level of expertise, those responses were categorized as low (no experience or beginner) vs. high (intermediate, advanced or expert). To investigate possible main effect interactions with GPA, self-reported GPA was categorized as low ($<= 2.5$), medium (> 2.5 but $<= 3.0$), or high (> 3.0). A significant difference ($p < .001$) was found between pre- and post-tests for the whole instrument, indicating a positive shift in attitude toward computers.

A significant interaction ($p < .01$) with pre-test perceived level of expertise was also found. Significant differences were also found in a positive direction on the liking ($p < .001$) and anxiety ($p < .001$) subscales. Both were found to interact with pre-test perceived level of expertise at the $p < .001$ level. No significant differences were found on the usefulness subscale or the programming subscale, although programming interacted with pre-test perceived level of expertise at the $p < .05$ level. A significant positive shift in perceived level of expertise was also found ($p < .001$). Possible reasons for the results, and the differences in the results between the two studies will be discussed and related to the content and format of the course in this paper.

Introduction

Instruction with and about computers has been a key theme in education during the last decade. The report *A Nation at Risk* (Gardner, 1983) cited computer competence as a fourth basic skill, along with reading, writing and arithmetic. Bruder (1988) has estimated that there are almost 1.5 million computers available in schools in the United States for students in grades K through 12. Students at every level have a good chance at experiencing instruction about or with computers as they pass through the educational system.

During the last decade, there has also been increased interest in the educational opportunities provided to preservice teachers so that they may be adequately prepared to both use computers in the teaching of traditional content areas and instruct students about computer use. Although the content for such a course of study has not yet been standardized nationally (Brownell, 1991) the Association for Computing Machinery published a special issue of *Outlook* (Lawson, 1988) as a beginning step in a dialogue designed to arrive at a set of guidelines for such a course. Also, the International Society for Technology in Education (ISTE) has published guidelines for accreditation of educational technology and computer programs (Thomas, Knezek, Taylor, Friske, Sloan, & Wiebe, 1992). The guidelines, which have been approved by the National Council for Accreditation of Teacher Education, include Foundation Standards with regard to the application of technology to education. These standards outline the educational technology concepts and skills which ISTE proposes that all teacher certification candidates should have.

As more and more teachers become responsible for using computers in their professional lives, preservice and inservice teachers' attitudes toward computers become an issue (Jay, 1981; Lawton and Gerschner, 1982; Stevens, 1980). As with any subject, a negative attitude may negatively affect the learning process. For the teacher engaged in learning about computers, this may ultimately affect the teacher's competence as a source of instruction about computers. Cambre and Cook (1984) found that teachers had a higher level of computer anxiety than did their students, while Koohang (1987) found that previous experience with computers (and the type of experience) was related to attitude about computers. Given the fact that more and more preservice teachers are being required to take a course on computers in education, it would be of benefit to view the effect such a course might have on the attitudes of preservice teachers. Following is a presentation of the results of two studies on attitude change toward computers in a required computer education course for preservice teachers.

Study One—Purpose

The purpose of this study was to investigate the following three questions: 1) Do undergraduate elementary education majors' attitudes toward computers change during a computer literacy for educators course?; 2) Do undergraduate elementary education majors perceive their levels of expertise with computers as changing during a computer literacy for educators course?; and 3) Is there an interaction between attitude change and course instructor?

Study One—Methods

Subjects for this study were 46 preservice elementary education majors at a large midwestern university. Subjects were in two separate sections ($n = 18$ and $n = 28$) of a required computer literacy course for educators. The course met for a five week period, four days per week, for two hours per day, for a total of 40 hours. Each section was taught by a different instructor. Course content was standardized across instructors. Topics covered in the course included: modes of educational computer use, software evaluation, word processing, spreadsheets, data bases, interactive videodisc use, telecommunications, the computer education curriculum, and Logo programming. Students were predominately female ($n = 41$) and in their senior year ($n = 33$).

At the beginning of the course all students were asked to complete a pre-test, which was a 19-item attitude instrument designed to measure attitudes toward computers in four areas: usefulness, liking, anxiety and programming. Student responses to each item were on a Likert scale ranging from Strongly Agree (1) to Strongly Disagree (5). Figure 1 presents the instrument. Items which comprise the subscales are: usefulness, items 4, 5, 6 and 7; liking, items 2, 10, 16 and 18; anxiety, items 3, 8, 9, 11, 12, 13, 14 and 17; and programming, items, 1, 15 and 19. Five scores are reported from the instrument, one score for each of the subscales for the areas cited, plus one overall score. Each score reported ranges between 1 and 5. (For a full description of the development of the instrument, please see Brownell, 1990.) Data were also gathered for each subject as to self-reported GPA, self-perceived level of computer expertise, and year in school.

For the following questionnaire, please indicate your thoughts and feelings about computers. For each of the items below, consider the following scale:

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

For each question, circle the number which best describes your response to the particular item. Please express your attitudes freely. There are no right or wrong responses.

1	2	3	4	5	1. Today's students need to know how to program a computer.
1	2	3	4	5	2. Computers are always causing me trouble.
1	2	3	4	5	3. Computers make me feel helpless.
1	2	3	4	5	4. All elementary students should use computers.
1	2	3	4	5	5. I would like to use a computer in my classroom.
1	2	3	4	5	6. Learning about computers is important.
1	2	3	4	5	7. Computers should be used in all school subjects.
1	2	3	4	5	8. I find computers very frustrating.
1	2	3	4	5	9. I look like a fool when I try to use a computer.
1	2	3	4	5	10. I avoid computers as much as possible.
1	2	3	4	5	11. Compared to other people in college, I know very little about computers.
1	2	3	4	5	12. I worry that my students may know more about computers than I do.
1	2	3	4	5	13. I feel nervous when using a computer.
1	2	3	4	5	14. Hearing others talk about computers makes me uneasy.
1	2	3	4	5	15. Every teacher should learn how to program a computer.
1	2	3	4	5	16. I feel comfortable working on a computer.
1	2	3	4	5	17. I'm afraid of computers.
1	2	3	4	5	18. I dislike computers.
1	2	3	4	5	19. Computer programming should be taught in the schools.

Figure 1. The computer attitude scale used in both studies.

The attitude instrument was administered again, as a post-test, at the end of the course. At that time, students were asked to report their perceived level of computer expertise again.

Study One—Results

The Cronbach's alpha calculation for the pre-test was .89 and for the post-test was .88. Repeated-measures ANOVA's were used to test for change from pre-test to post-test for each subscale, for the total instrument, for perceived level of expertise with computers and for interaction by instructor for any of these measures. Table 1 gives the results of the repeated-measures ANOVA's. It lists pre-test and post-test scores, by instructor, for each of the four subscales of the attitude instrument and for the overall score on the instrument. Note that a lower score indicates a more positive attitude.

Scores on the usefulness, liking, and anxiety subscales were all significant at the $p < .001$ level and all showed a change toward a more positive attitude. The programming subscale scores were significant at the $p < .05$ level and showed a change toward a more negative attitude toward programming. The pre-test and post-test scores for the total instrument were significant at the $p < .001$ level and showed a shift toward a more positive overall attitude as measured by the instrument. An increase in perceived level of expertise, shown in Table 2, was significant at the $p < .001$ level. For this item, a higher score indicates an increase in self-perceived level of expertise regarding computers. No interaction was found between any instructor and any measure.

Study One—Discussion

While students' overall attitudes toward computers changed significantly in a positive direction during the course, the findings by subscales are of particular interest. The usefulness, liking and anxiety subscales indicated a positive, significant change in attitude. The programming subscale, however, indicated a significant negative shift;

Table 1
Study 1 Results from Repeated-Measures ANOVA's: Attitude Scores (Subscales and Overall)

	N	Pre	Post
Usefulness *			
Instructor A	28	1.99	1.56
Instructor B	18	1.97	1.60
Liking *			
Instructor A	28	2.40	1.77
Instructor B	18	2.25	1.65
Anxiety *			
Instructor A	28	2.55	1.87
Instructor B	18	2.71	1.87
Programming **			
Instructor A	28	2.43	2.70
Instructor B	18	2.22	2.59
Overall Score *			
Instructor A	28	2.38	1.92
Instructor B	18	2.38	1.88

* $p < .001$
** $p < .05$
Note. A 1 to 5 scale was used with a shift to a lower score indicating a more positive attitude.

Table 2
Study 1 Results from Repeated-Measures ANOVA's: Students' Perceived Level of Expertise

	N	Pre	Post
Perceived Level of Expertise *			
Instructor A	27	2.37	3.07
Instructor B	18	2.39	2.89

* $p < .001$
Note. A 1 to 5 scale was used with a shift to a higher score indicating a self-perceived gain in knowledge of computer use.

students liked programming less at the end of the course than at the beginning. In fact, students' attitudes were still on the positive side of neutral with regard to programming by the end of the course, but had shifted more toward neutral. One possibility is that, having been exposed to a variety of uses of technology in the classroom other than programming, students perceived programming less favorably than they did previously. Participants may simply have gained more information about educational computing, and that information may have affected their view of programming. Another possibility is that the programming module taught in the course may need to be improved.

It is also interesting that no instructor interactions were found; students essentially had the same attitude shift regardless of which instructor taught their section of the course. This is important finding, because the course content had been standardized previously in an attempt to provide a more consistent product to students. That consistency appears to have been realized, at least in terms of attitude change.

According to the data, students report that their knowledge about using computers and that their attitude toward computers has, overall, improved positively. These are two goals of the course and students in these two groups appear to believe that the goals were successfully accomplished.

Study Two—Purpose

The purpose of the second study was to investigate the following three questions; 1) Do undergraduate elementary education majors' attitudes toward computers change during a computer literacy for educators course?; 2) Do undergraduate elementary education majors perceive their level of computer expertise as changing during a computer literacy for educators course?; and 3) Is there an interaction between attitude change and any of the following variables: pre-test perceived level of computer expertise, GPA, or year in school?

Study Two—Methods

Subjects in the second study were elementary education majors at the same large midwestern university (n = 130). Participants were taking the same required computer literacy for educators course as subjects in the first study. Topics in the course were the same as in the previous study. However, the format of the course was different. In this study, students attended one 1 1/2 hour per week lecture and then one 1 1/2 hour per week lab. Students were divided into six sections. Lab sessions were held for each individual section while lecture sessions were held with three sections combined. Total course enrollment was 155. The 130 participants represent the 130 sets of complete data obtained from students. The missing 25 sets of data were caused by student absence during pre-test or during post-test administration. Subjects were predominantly female (92.3%), juniors (51.2%), and seniors (29.4%). 19.4% of the subjects were sophomores. There were no freshman in the sample. The range of self-reported GPA was 2.0 to 4.0, with a mean of 2.98, and a standard deviation of .42.

The 19-item attitude instrument used in the first study was administered as a pre-test at the beginning of the course (see Figure 1). Data were also gathered for each subject on self-reported GPA as well as self-perceived level of expertise regarding computers and year in school.

Table 3
Study 2 Results from Repeated-Measures ANOVA's: Attitude Scores (Subscales and Overall)

	N	Pre	Post	Interaction
Usefulness	130	1.97	1.80	Expertise GPA Year in School
Liking *	130	2.35	1.94	Expertise * GPA Year in School
Anxiety *	130	2.04	1.62	Expertise * GPA Year in School
Programming	130	2.57	2.69	Expertise *** GPA Year in School
Total Score *	130	2.37	2.07	Expertise ** GPA Year in School

* $p < .001$
** $p < .01$
*** $p < .05$
Note. A 1 to 5 scale was used with a shift to a lower score indicating a more positive attitude.

The attitude instrument was administered again, as a post-test, at the end of the course, and students were again asked to report their perceived level of expertise with computers.

Study Two—Results

The Cronbach's alpha calculation for this study was .91 for the pre-test and .90 for the post-test. Repeated-measures ANOVA's were used to test for change from pre-test to post-test for each subscale, for the total instrument, for perceived level of expertise with computers and for main effect interactions with perceived level of computer expertise, GPA and year in school. To investigate possible main effect interactions with perceived level of expertise, responses for this item were categorized as low (no experience or beginner) vs. high (intermediate, advanced or expert). To investigate possible main effect interactions with GPA, self-reported GPA was categorized as low (<= 2.5), medium (> 2.5 but <= 3.0), or high (> 3.0).

Table 3 presents the results for the attitude instrument. A significant pre-test to post-test difference ($p < .001$) was found for the entire attitude instrument with an indication of a positive shift in students' attitudes. Perceived level of expertise was found to significantly interact ($p < .01$ level) with students' scores on the total instrument. There were significant differences ($p < .001$) in a positive direction for both the liking and anxiety subscales and both were found to significantly interact ($p < .001$ level) with perceived level of expertise. No significant differences were found on the usefulness or the programming subscales, although programming interacted with perceived level of expertise at the $p < .05$ level.

Tukey's Studentized Range Tests were run post-hoc to investigate the interactions found. They indicated that, at the $p < .05$ level, pre-test self-perceived computer expertise interacted with total attitude score, and with the anxiety subscale, whether the student responded as having a low level of expertise (none or beginner) or as having a high level of expertise (intermediate, advanced or expert). At the $p < .05$ level, the interaction of pre-test self-perceived computer expertise with liking, and also with programming, only occurred when students responded as having a self-perceived low level of expertise.

Table 4 presents the results of the Repeated-measures ANOVA's for perceived level of expertise. A significant difference ($p < .001$) was found which indicated a positive shift in student's self-perceived level of expertise regarding computers.

Study Two—Discussion

It is interesting that students' overall attitude toward computers changed significantly in a positive direction, since this is one goal of the course. It is also interesting that students perceived themselves as having more expertise with computers at the end of the course than they did at the beginning.

The subscale data indicates that students appear to increase their liking and decrease their anxiety toward computers while participating in the course; two desired results. While students did not significantly gain a more positive attitude toward usefulness, it should be noted that the shift, although not statistically significant,was in a positive direction and approached significance ($p = .057$). It is encouraging that there was no statistically significant negative shift in attitude toward programming, but it is disturbing that the shift was in a negative direction. One reason for the direction of this shift may be that students, upon entering the course, often verbally express a strongly held negative attitude toward programming due to previous negative programming experiences. They often appear to adopt a "wait and see" attitude about the programming module in the course (hence, the "middle-of-the-road" responses about programming during the pre-test). The results here may mean that students are still not convinced about the educational value of teaching and learning programming skills. It may be that a different approach to the programming module will be needed to help students feel more favorably about programming in education.

Table 4
Study 2 Results of Repeated-Measures ANOVA's: Students' Perceived Level of Expertise

	N	Pre	Post
Perceived Level of Expertise *	130	2.52	2.93

* $p < .001$
Note. A 1 to 5 scale was used with a shift to a higher score indicating a self-perceived gain in knowledge of computer use.

The interactions found, if not surprising, are of special interest. Pre-test self-perceived level of computer expertise interacted with total attitude score, and with the anxiety subscale score, whether the student responded as having a low level of expertise (none or beginner) or as having a high level of expertise (intermediate, advanced or expert). In this instance it appears that students' perceptions of their computer skill were related to both their change in attitude toward computers overall during the course, and a reduction in anxiety about computers. The interaction of pre-test self-perceived computer expertise and liking, and also with programming, however, occurred only when students responded as having a low level of expertise. A more negative view of one's computer expertise may be related to attitude change regarding liking and to attitude toward programming.

One outcome of the attitude change reflected in the study may be that students seek out more experiences with computing in education. With regard to the interactions cited above, it might be that students' improved perception of their computer expertise will also assist in leading them to more experiences with computers in the future.

Conclusion

The findings of both studies seem to support the idea that students' attitude toward computers positively changed during the course. This appeared to occur regardless of course format. The programming finding in the first study was disappointing, although this finding was mitigated somewhat in the second study. It appears that course content may need to be altered to overcome what seems to be strongly held attitudes regarding programming. One option is to integrate collaborative learning techniques into the programming module. Another option is to change the specific Logo activities and/or the duration of the module. A next step in research beyond the current study will be to vary content (such as the programming module) and more closely track students' attitudes with respect to the content varied.

Additional studies of attitude change during similar courses would be valuable. We need to know how students view computing and what effect we, as instructors, may have upon those views. If we improve computing skills without improving students' attitudes toward computers, we will not be doing all we can to help increase the productive use of technology in the schools.

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Writing assignments in educational computing and instructional technology classes

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The processes of learning and writing are powerfully linked. Fulwiler (1987) asserts that "writing is basic to thinking about, and learning, knowledge in all fields as well as communicating that knowledge" (p. 1). Elbow (1986) concurs, observing that writing leads to more detailed and complete thinking as the writer explores connections and different organizational patterns in the material to be learned. Another potential benefit of writing has to do with what Marton (1975) calls surface and deep approaches to learning. Many college teachers are frustrated by the tendency of students to take a *surface approach to learning,* meaning that they pursue their studies with a minimum of personal engagement, satisfied to memorize facts and procedures without attempting to understand them. Only a small minority routinely adopt a *deep approach to learning*, delving into the meanings of lectures and readings, asking probing questions, voluntarily doing outside reading, and relating class material to material in other subjects and to their own experience.

Taking a surface approach to learning may be especially common as teacher education students learn about technology. It is all too easy for them to simply learn the steps in using a particular computer program or bulletin board without really understanding what they are doing or how to apply it in the classroom once the course is over. Even when technology is integrated into methods courses, students often miss the connections between what they are learning and what they can use in their classrooms in the future. Most of us would prefer that students adopt a deeper approach to educational technology, but how do we get them to do that?

Certain instructional methods promote a deep approach to learning by encouraging students to relate material to their lives and by assigning tasks that require deeper thinking about the subject (Entwistle, 1988; Ramsden, 1988). Writing can serve both of these functions. In a recent paper, Brent and Felder (1992) show how suitably designed writing assignments can induce students to deepen their approach to any subject. In this paper I will suggest a variety of writing assignments for educational computing and instructional technology courses or methods courses with a technology component. Most of the assignments can be completed quickly by the students and evaluated cursorily or not at all by the instructor. The assignments are designed to stimulate students to (1) explore their own attitudes and background knowledge; (2) clarify, organize, and summarize what they are learning; (3) improve critical thinking skills; and (4) apply what they have learned to their own classrooms. The assignments are written in italics with possible variations in parentheses. Notes are interspersed to explain the educational function of each assignment and its role in motivating a deep approach to learning.

Exploring initial attitudes and activating background knowledge

Since students' initial attitudes toward a subject can affect their willingness and ability to learn the course material, it is helpful for instructors and students to be aware of those attitudes from the outset. Many students have strong fears associated with any type of technology; others may be convinced they already know everything the instructor has to teach them. Both attitudes can inhibit learning and are often present in different members of the same class. A good way to bring these attitudes to the surface is to ask the students to write about their feelings as they begin the course. For example, "What have you heard about this course? What are your feelings about starting it? What grade do you expect to get in it?"

Psychological research has shown that learning does not take place in a vacuum; rather, people learn by assimilating new information into existing cognitive structures (Gagne, 1985). Stimulating students to recall things they already know that are related to the course content can substantially increase the likelihood that they will be successful in learning the material. For example, "Briefly summarize what you know or have heard about spreadsheets (or drill and practice programs, Logo, telecommunications, electronic bulletin boards, word processing)."

An effective way to encourage students to tap into what they know and pinpoint what they do not yet know or understand about a subject is to ask them to generate a list of questions. For example, "List seven questions or things you don't know about how a computer works (i.e., HyperCard, computer simulations, laser discs, computer graphics). For each question you list, indicate why it might be important to know the answer." Once generated, the list provides motivation and focus for learning the material to be taught. An even deeper level of thought about the material may be induced by asking the students to predict the answers to some of the questions.

An apparently necessary condition for most students to adopt a deep approach to learning is that they perceive the relevance of the subject to their lives. One of the best ways to establish relevance is to get the students to do it for themselves. For example, "List situations in your life when you could use a database (graphics program, Lotus 1-2-3)."

All of these exercises may be done in class or as homework. Having students keep a journal or a section in their notebooks for entries of this type is a good way to organize the writing, and it allows students to go back and reread previous responses. Listing or other brainstorming activities might first be done individually and then followed by brief sharing and discussion of written responses in groups of 3-5 in class, exposing the students to a wider variety of ideas than they were able to generate individually. Most or all of the students in a class would be involved in this exercise, unlike the traditional approach in which a few students are called on individually; moreover, if the discussion takes place the instructor does not have to collect and read all the responses to the assignments to have the desired effect on students' learning.

Clarifying, organizing, and summarizing new information

As in many courses, courses on educational computing and instructional technology tend to include a great deal of information and a wide variety of applications. Students can easily become overwhelmed and may find themselves mindlessly going from one requirement to another without taking time to reflect on what they have learned and how information and applications are related to one another. Writing assignments such as the following can provide such opportunities for reflection.

Review what you know at this point about hypermedia (interactive videodiscs, simulations, random access memory). *What points or questions would you like to discuss further?*

Look back at the questions that you listed before we began this topic. Are there any to which you still don't have answers? Are they important? How might you go about getting the answers?

What are the similarities between using a computer drill and practice program and using a computer simulation (spreadsheet and database)*?*

After completing such assignments, students generally have a much clearer idea of what they know and where there are gaps in their knowledge. In addition, students who have had the time to organize their thoughts in writing tend to be more willing to contribute to class discussion.

Some instructors routinely have students write summaries of what they have learned in a class session and turn in their writing before leaving the class session. The instructor can then scan the comments to determine how students grasped the material.

What is the most important thing you learned about programming (hard drives, FrEdWriter, management systems) *in class today? What is your main unanswered question?*

Prepare a one-sentence (one-paragraph, one-minute) *summary of the main idea of this class period.*

Improving critical thinking skills

Critical thinking involves examination and analysis of information to draw and justify conclusions regarding its validity. Critical thinking skills include abilities to draw sound inferences, evaluate credibility and reliability of sources, identify main ideas, underlying assumptions, and logical fallacies, and synthesize ideas (Kurfiss, 1988). These thinking skills are teachable if they are modeled by instructors and practiced by students. The following writing prompts can help to encourage use and development of critical thinking skills in instructional technology courses, or educational methods courses that integrate the use of educational technologies.

Now that you have generated a graph of the data (calculated the mean and standard deviation, generated the grade list), *how can you be sure the results are correct?*

Which of these simulations is most user-friendly (appropriate for teaching this concept, realistic)*? Support your opinion.*

What is the underlying model of teaching being used in this software?

Excellent opportunities for critical thinking present themselves when students are programming or making use of authoring systems. The process of programming itself requires analysis of assumptions, predictions of what user reactions and problems will be, and determination of appropriate steps to take in completing programming tasks. Writing assignments like the following help students to focus upon these types of thinking.

Before you begin to design your tutorial using Authorware (orHyperCard, LinkWay), *list what you know about your students and the steps you will take in completing the project.*

Suppose you you go to a pulldown menu in your tutorial and you can't get back to where you started, brainstorm possible reasons for the problem. What steps can you take to solve it?

Are there possible user responses you haven't accounted for? How could you modify your program to account for them?

Assignments such as these that call upon education students to exercise critical thinking skills help them to develop those skills and therefore increase the probability that they will require similar types of thinking from their own students.

Applying learned material to the K-12 classroom

An important purpose of teaching about technology in teacher education programs is to help students use what they have learned in the course to enhance instruction in their classrooms. Too often, students are introduced to a variety of technological applications in a university class and never see them again. One way to keep that from happening is to encourage students to apply what they are learning to real K-12 classrooms. Such applications require teachers' creativity and an understanding of the technology that goes beyond the simple ability to use it for themselves.

How many ways can you think of to use telecommunications (databases, videodiscs, graphing packages) *in your primary* (intermediate, middle school, physics, general math, biology, English composition) *classroom?*

Choose one of the simulations discussed in class and incorporate it into a lesson or series of lessons for your grade level or subject area.

A potential benefit of exercises of this type is that students who plan to teach a given subject or grade level can work together in teams, sharing and adding to each other's ideas. Another possibility is to put together teams of students from different backgrounds, in which they can help one another look at assigned tasks from a variety of perspectives. If students come up with especially good ideas, they might distribute copies of them to the class so that everyone benefits from their creative processes.

Suggestions for using a variety of writing assignments

1. Don't set out to incorporate all of these ideas at once. Start by trying one or two ideas that appeal to you. As you become comfortable with those that work for you, add more.
2. Clearly relate writing assignments to course content. Students are more receptive to new approaches when they understand their relevance and importance.
3. Try new writing assignments several times before deciding upon their effectiveness. Students usually need at least three attempts at new tasks like brainstorming or summarizing before they begin to understand their relevance.
4. All of the writing assignments described in this article can be completed in or out of class. In either case, set aside a brief period of time for in-class sharing of ideas and opinions in groups of three to five students. Small group discussions expose students to new ideas and help them to clarify their own ideas.
5. Many of the assignments require no feedback from the instructor; the process is more important than the product. But for assignments that do result in a product (lesson plans, unit plans, original programs), make sure students get constructive feedback on their initial efforts. At first feedback will have to come from you, but the students themselves can later be trained to give helpful feedback to one another.
6. Ask students to evaluate particular assignments and the writing experience as a whole. Make changes in assignments that do not seem to be accomplishing their planned objectives.
7. Write and publish articles about assignments that work well so that other instructors can experience the benefit of your work.

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Individualized planning and facilitation in teaching educational computing strategies

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Introduction

During the last decade, more than two million microcomputers made their way into American classrooms. The number of schools that own computers jumped from approximately 25 percent in 1981 to virtually 100 percent by the end of the decade (Kinnaman, 1990). According to one survey result, more than $12 billion had been spent on computer hardware and software for schools in ten years (Instructor, 1991). This flooding of software into schools generated an immense interest in computer aided instruction (CAI) among educators. The *Smart Classroom* project was set up in California (Slaughter, 1989), the *CHILD* (Computers Helping Instruction and Learning Development) project was developed in Florida (Butzin, 1991), and the Calvert Country School district in Maryland claimed computer aided instruction as a major success (Austin and Howie, 1990). While some researchers were still studying reasons for the success and failure of technology (Gayeski, 1989), more and more educational practitioners were exploring creative ways to integrate software into classroom teaching.

This integration required the services of a large number of creative teachers who were equipped with successful educational computing strategies. While teacher technophobia was disappearing (Instructor, 1991), educators were far from being well-prepared for riding on top of this tide of curricular change. Demand for educational innovators with computer integration skills was expressed as a call for new graduate courses in educational computing. Among these courses was *Educational Computing Strategies* at Shippensburg University of Pennsylvania . The purpose of this course was to train educational innovators who would play leading roles in exploring educational software and creatively integrating it into schools' curricula.

Educational Computing Strategies was a unique course because it accepted in-service teachers from any discipline, at any grade level, and with any level of computer skill. The first 17 graduate students enrolled in this course were in-service teachers whose teaching responsibilities ranged from special education in Chapter I elementary programs to computer instruction at a military institution, and their previous computer training ranged from 0 to 27 computer-related course credits.

With such a diverse population of in-service teachers in one class, traditional teacher-centered instruction became inappropriate. There was no ready- made strategy that could be applicable to every student. Some of the students were experienced computer instructors and some had never used database and spreadsheet programs. After consultation with the learners, the writer initiated an individualized instructional plan that was based on the needs of the learners, and incorporated principles of research and theory on adult learning. This paper reports this learning process and highlights the six characteristics of this individualized plan that the instructor used in facilitating her diverse students' learning.

Needs Assessment

If needs assessment is important in any educational program, it was absolutely essential in this course. On the first day of the class, a self- designed assessment form was used to find out how many computer credits these in-service teachers had taken, what those computer-related courses were, what software they had used before, what courses they were teaching, and how they were planning to use software in the near future. The results were startling.

Among the 17 in-service teachers, 4 had more than 20 computer credits; one had reached 27. The courses they had taken had focussed upon Logo, BASIC, Pascal, Fortran, Cobal, HyperCard, utility systems, digital design, hypermedia, and general computer courses. The group consisted primarily of high school and college math and computer teachers.

In contrast to this group, the other 13 students had fewer hours of training in computer science, but had more experience using courseware in classrooms. They were mostly elementary school teachers. Two of these students didn't have any computer training, and the rest had a moderate amount of computer experience. The average amount of previous training was 12.5 computer course credits.

In accordance with past precedent in the Teacher Education department at Shippensburg University, the instructor had prepared a syllabus that was heavily geared toward the application of courseware in the elementary curriculum, only to find that it was irrelevant to over half of the in-service teachers, who were not elementary teachers, and had no intention of becoming primary-level teachers in the near future. Each was using different software packages (some not at all), teaching different aspects of computing, and had different expectations for the outcomes of this course. One set of courseware that was appropriate for one group was totally useless for another group. Some essential computer skills, such as spreadsheet and database familiarity, were novel for one group, but could bore the other group to death. Unable to accommodate such diversity, the first syllabus was trashed.

Individualized Planning

Individualized instruction was the best way to accommodate diversity in this class. It was, however, also one of the most difficult teaching strategies to employ, as it required stronger instructor commitment, prolonged preparation time, and mastery of pedagogy. Nevertheless, It was the only workable alternative in the instructor's opinion at the time. Fortunately, since the class was comprised of experienced teachers, the instructor could utilize principles of adult education which centered on students' rich experience gained through project work (Gibb, 1970).

The instructor talked with each in-service teacher to explore their personal interests, computer expertise, possibilities for workable projects, and expectations for course outcomes. She established a communication file for each student, mapped the possible scope of the course and wrote down each individual's expertise and needs. Based on these information, the second syllabus was developed.

The second syllabus was highly individualized. It was based on students' experience and oriented toward their special needs. It emphasized creative use of computer programs, and covered a much broader range of learning. Students were given a diagram of the scope of the course which ranged from background knowledge in educational computing, skills needed to use integrated software packages, software usage and selection, innovative software applications, telecommunications, courseware design, integrating computer use into the curriculum, enhancing CAI development, and coordinating the use of CAI systems. Each learner selected learning goals based upon individual needs and built skills successively upon previous experience.

The second syllabus required students to attend two-thirds of the scheduled class periods, so that the instructor could use the other one-third of classtime to provide needed remedial or enrichment activities. Students were free to substitute their own materials for the materials suggested by the instructor to meet the requirements of the course. For example, when evaluating software, each student was given 5 different kinds of evaluation forms. They were required to fill up two of them, preferably evaluating software that would be most useful to them with the form(s) that would best serve their purposes. If the university's lab didn't have the hardware they needed to run the software that they had selected, they could take the project home to finish the evaluation and use their university lab time to learn other skills. The evaluation of each student's work in the course was based on individual progress compared with prior experience.

Incorporating Learners' Rich Experience

The in-service teachers who registered for this course were college computer instructors and school software users. They had much of value to share. For instance, to explore current computer use in schools, students were assigned a brief research project on computer usage in their own school, school district, or college. Each was given a list of questions that addressed such topics as hardware and software usage, location of computers, instructional time, and available training programs. They brought back fascinating information to share with the class. Their research revealed a huge imbalance in the distribution and application of computers. One new elementary school could not afford to buy any computers, and a military college literally had more computers than students. The results of this research highlighted many of the important issues that were discussed later in the class.

Throughout the course, the teachers were invited to present their work. They shared their self-designed math courseware, history tutorials, testing programs, and instructional design techniques. They brought their favorite software to demonstrate in class. For example, one elementary teacher shared the *Amazing Window* gradebook program in class, along with sample printouts. This put many self-designed spreadsheet gradebooks out of favor with her classmates, because the professionally designed gradebook was much more powerful. Her creative use of the *Amazing Window* program provided many new ideas for others to use to improve home-designed spreadsheet gradebooks. In another example, a demonstration of the creative use of a remedial program for Chapter I students (*Master Spell*) introduced new possibilities for high school and college computer instructors. Some commented that they did not realize that there were so many good software packages designed for the elementary levels and so many creative ways of using them.

Individualized Facilitation

Due to the variation of computer brands purchased for schools, in-service teachers used different integrated software packages for their classwork. For example, most high school and college teachers in the class used IBM or IBM compatible machines, hence, *Microsoft Works*, *WordPerfect*, *dBase IV*, and *Lotus 1-2-3*; whereas most elementary teachers in the class didn't want to have anything to do with IBM hardware or software, because the only available computers to them were Apples. If they wanted to learn new programs they wanted to use the *Writing Center*, or *Microsoft Works* on the Macintosh. Some wanted to learn to use the database and spreadsheet in *AppleWorks.*

Educational Computing Strategies was a class in which students developed creative ways of using software. It was not a hands-on training in basic skills; most of the students had already attained that level of computer competency. But for those who hadn't learned to use, for example, databases and spreadsheets, their creativity in software integration would have been greatly limited by a lack of familiarity with some application types. To this end, the instructor condensed the *AppleWorks* introduction into a printed manual that took 3 hours for students to complete and provided a remedial course for those in need of database and spreadsheet skills. For students who needed graphics and desktop publication skills, the *Writing Center* was introduced. Every student was provided with a code that allowed access to the university's telecommunications system. Special time was set aside for those who wanted to learn *Microsoft Works* and have some mainframe experience. In spite of these remedial and enrichment programs, the emphasis of the course remained upon creative use, selection, and development of software to integrate into the K-12 curriculum.

Emphasizing Themes and Outcomes

Educational software is a late 20th century invention. Through its growth has been rapid, educational software is meaningful only when it can increase productive learning. This phenomenon depends largely upon the willingness and creativity of the teachers who use it. Educational software is only as effective as the pedagogic creativity of the teachers who use it.

The in-service teachers in the Shippensburg course will play a leading role in integrating software use into the curriculum at their institutions or school districts. As there were few rules in the course design to restrict the nature of their innovations, they were encouraged to explore all possibilities. The only requirements for their final project were that it had to represent an improvement upon their teaching, and it had to be relevant to the curriculum that they wree responsible for teaching. The creativity demonstrated at the course was boundless.

The in-class presentation of the final projects was the highlight of the course. They included Logo in the Math curriculum, spreadsheet use in Consumer Math, a self-designed authoring language, adapting spelling program to accommodate remedial students, self-designed history programs, an examination of computer roles in whole language methods, a grant proposal to obtain hardware and calculus courseware, and a long range technology plan for an elementary school.

Evaluation on Individual Learning Process

The students were evaluated based upon the individual advancement of their learning. Evaluation procedures consisted of a written test, class activities, and a final project. The students with fewer computer credits were not necessarily put in a disadvantaged position. The written test put more emphasis upon essential computer terms and CAI strategies than upon sophisticated computer terminology. Anyone in the class who had read the textbook thoroughly was able to score 80% or above on the test. Classroom activities such as research reports, CAI teaching plans, creative products, software evaluations, and final projects were assigned point totals. The student-designed applications and final projects outweighed the written test in determining final grades. When evaluating final projects, the instructor gave great consideration to where each student started, how much each had accomplished during the course, and the quality of the final product.

Discussion

Individualized instruction is no easy commitment, as it requires substantially more time and effort. For example, if an instructor is going to explain CAI strategies using a traditional method, s/he may go through a group of software programs, pick out a few of them that represent different modes of instruction, and demonstrate them to the class, but if s/he is open to software used at all grades and all disciplines, s/he has to go through hundreds of software programs and still feels insufficiently prepared. By the same token, if s/he is to explain the instructional design of software to a traditionally-taught class, s/he may select one or two representative pieces of software and demonstrate them in the class. With individualized instruction, however, s/he must prepare for all kinds of challenges and be ready to learn from her students.

Individualized instruction turns the traditional teacher-centered classroom into a student-centered learning environment. It will make some teachers very uncomfortable, because it is indeed challenging and time-consuming. Nevertheless, teachers who truly value each student's uniqueness and experience should give it a try when necessary. It has been a truly rewarding experience to both students and the instructor in this course.

Individualized instruction is rewarding to the students because it allows them to express their creativity without hindrance. It centers upon their needs, incorporates their past experience into their present learning, tailors outcome objectives according to their future work, and evaluates their achievement based upon individual progress. Students feel respected and hence are more likely to be actively involved in the learning process. Individualized instruction is rewarding to the instructor because it provides great learning opportunities. Many educator-turned- computer-practitioners have a hard time catching up with the latest developments in technology and school curriculum reform. Learning from in-service teachers is a wonderful way to stay current and connected.

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MULTIMEDIA

What Happened to the Videodisc?

It seems that just a few years ago, interactive videodisc technology was the ultimate in hyper/multimedia technology. Yet, in the articles written for this Annual, scant mention is made of videodisc technology. Not that the authors are suggesting that we abandon the use of videodiscs, but it appears that the technology has become accepted as an integral part of technology-using educators. To this, we must say 'Bravo'. Rarely has a technology become so incorporated into the curriculum so quickly as to become almost invisible, much like the textbook or the overhead projector or even the computer. Most of us would not think of teaching today without the use of educational technology and it appears that videodisc technology has become an accepted addition to the classroom.

The acceptance of this technology in a relatively short period of time makes the articles for this Annual much more meaningful. Which of the innovations covered in these articles will become another educational tool which is seamlessly incorporated into the curriculum? Which will become merely passing phases which we will learn from, adapt, and improve upon? If someone had mentioned five years ago, that videodisc technology would become an accepted part of our curriculum (look, for example, at Florida's outstanding record of providing each school in the state with videodisc equipment), would we have considered this wishful thinking or would we have started to develop curriculum which could make full use of this equipment? The questions raised and solutions offered in this series of articles may sound like wishful thinking to some, but in each case, raise a number of possibilities and a great deal of potential.

Anderson and Howard explore the use of QuickTime and HyperCard to develop materials utilized in an early childhood special education course on the theory and instruction of language. The emphasis is on the importance of modeling computer use by educators in higher education and the integration of technology into the classroom. Braswell and Brown discuss the use of CD-ROM technology in the classroom, focusing on exemplary CD-ROM products which demonstrate both excellence in design and in potential for classroom use. Jafari discusses the need of a new type of technology system, the Human Technology Interface, which will simplify the use of technology in the classroom. Javetz examines the benefits and problems inherent in training teachers to become hypermedia authors and offers suggestions for the study of such training. Kearney provides two powerful articles. The first article discusses the potential for the use of multimedia in the marketing of schools and provides excellent examples of how one school system is utilizing this technology to provide information about their magnet schools. The second

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article revolves around the potential for the use of virtual reality in the San Diego school systems. This article provides a much needed overview of a real-life experience with the use of virtual reality in the schools. Ritchie and Stollenwerk hark back to an much underutilized technology available in most schools today: the VCR. This article reminds us that one does not need to have the most expensive nor the latest in technology to provide powerful learning experiences for our students. Sridhar and Levin return us to the world of QuickTime applications with a look at the use of QuickTime video to demonstrate information which would have only recently been rarely taught utilizing any type of technology. Swartz reminds us that the days of the chalkboard may soon be surpassed through the use and benefits of a multiscreen classroom. Their potential for use in assisting teacher-student interaction should not be overlooked. Bedhar, Ryan and Sweeder have investigated and propose an increased use in departmental collaboration in the use of technology to enhance the effectiveness of the student teacher practicum. Their overview of the process needed to develop materials to be used by the student teachers should prove valuable to other educators. Finally, Vess and Alexander utilize a relatively new technology (the PhotoCD) in order to provide a much needed service for the students on their campus. It is this type of forward thinking which provides much excitement for the utilization of technology in education today.

Rarely have I seen such a diverse group of articles which incorporate one theme: the use of technology, in its many forms, is continuing to grow, adapt and provide tools which we, as educators, will be using far into the future. The potential is ours to use!

Integrating computers and curriculum content in higher education

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While innovative technology has drastically changed the world of work, the same technology has had little widespread effect upon the field of education. In 1962, Rogers noted that educational innovations of any kind lagged about 25 years behind educational research that identifies successful educational practices. This delayed response phenomenon seems to hold true for computers in education, particularly in higher education (Nicklin, 1992). Researchers have suggested that, under certain conditions, computer technology can increase learning efficiency, can serve as a motivational factor for students, and is especially effective for at-risk and special education students (Bangert-Drowns, 1985; Herman, 1988; Bialo & Sivin, 1990).

Before educators can envision the link between their curriculum area and the computer as a single educational tool for the informational age, leaders of curriculum areas must be assured that technology can make a difference for their students (Mecklenburger, 1988). Curriculum leaders must also demonstrate that technology can be used "to improve the quality of the curriculum" (Levinson, 1990, p. 125). However, few attempts have been made to evaluate the relationship between curriculum in higher education and computers used for delivery of that curriculum. Moreover, it is especially imperative that classes taught to pre-service teachers model the use of technology in curriculum delivery. According to Kendall-Mitchell (1991), "The domains of curriculum and instruction must be intermingled in order to promote an information age learning environment for students. This is a real departure from the traditional faculty development program which specializes in instructional strategies only" (p. 7).

The need to have college professors teach and model the use of technology in delivery of their curriculum was made clear in recent unpublished manuscript (Zilar, 1992).

> I think [students] in teacher training programs do need to have computer experience in order to qualify for graduation, but these same teacher trainees need to be shown by their own role models [college professors] how computers will help them within their primary endorsement areas. My own experience would attest to this. I was able to find only one professor in my academic major during my undergraduate career who knew anything about what computers could do for me in the physical education field. The other physical education teachers were just as illiterate about computers as I. I later found that my friends in the other departments had similar experiences with their professors.

A report from members of an American Association for Colleges of Teacher Education (AACTE) task force on technology made 10 recommendations for Dean of Schools of Education (Uhlig & Tucker, 1988). Among these recommendations were two that are especially relevant to the present project. The task force wrote, "Information technology is a critical resource in the effective delivery of instruction...[because] how information is accessed, managed, evaluated, and reported will be increasingly more important to effective learners" (p. 6). A second consideration related to the responsibility of individual professors to remain continuously informed about new products in technology, rejecting innovations only when they have developed a sound basis for understanding technology.

Integration Development Process

At Gonzaga University, two professors, seeing the potential for sharing expertise, agreed to team teach an early childhood special education course on the theory and instruction of language. The goal was to team teach the course the first semester, and thereafter, the special education professor would have learned the skills necessary to integrate technology into her course independently—hence freeing the computer professor to team teach courses with other faculty in the School of Education to achieve the same goal.

Attending a one day planning retreat several months prior to the course initiation, provided the basis for exploration of optimal merging of the technologies. During the planning discussion, the Language professor described major student objectives of the course in terms of knowledge base and practical applications. While not attempting in any way to master the core content, the technology professor sought to understand the principles of the course well enough to pair these principles and student expectations with current technology. The two brainstormed, questioned, refined, and revised the scope of the project. As the direction of the course activities became clear, it appeared that an interactive data base would be most appropriate for the students to learn and apply the major content of the course. HyperCard software was chosen to construct the data base. Moreover, as the technology professor described the evolving potential of Quicktime, it was determined that this software would provide students a way of making their language projects "come alive" by inserting into the HyperCard stack real footage of children communicating.

Once the technology was chosen, the next step was to plan how the curriculum would be utilized within the software. The project would require students to move through several stages, gradually building the substance of their data-base. The framework for the HyperCard stacks which would be used to build student programs was mapped out on paper, and then a template was created for the course. (See Fig. 1) A pilot of the project was conducted before the course began. One student went through the program, learning HyperCard as well as entering data based upon knowledge from the course text. As she went through the program she provided ongoing feedback on the structure and content of the template as well as the legitimacy of the learning process.

The course syllabus offered a calendar for presentation which was loosely structured, since the amount of time which would be required to teach the course content and the computer components together was unknown. Designed to teach students in a step by step process, course content was presented in a traditional format by the language professor first — followed by instruction in the computer lab by the technology professor to demonstrate the manner in which the content would be applied. Practice on the technology with assistance by both professors ensued. The remainder of the project followed in a similar manner (lecture—computer instruction—practice), throughout the remainder of the course.

Description of Project

An early childhood special education course in Language and Communication served as the forum for integration of electronic technology. The goal of this course was to prepare preschool educators to design and implement programs to enhance language development of young children with disabilities. This course had historically been taught through traditional methods including lecture, in class simulations, frequent quizzing and an associated practicum. A textbook by McCormick and Schiefelbusch (*Early Language Intervention*, 1990) provided the course content. This content was viewed by students as being conceptually difficult, and attempts at direct application of content to previous practicum projects revealed that student's lacked confidence (and skill) in decision making. In fact, it seemed that a major portion of the course content could be viewed as a multistage process of decision making—perfectly amenable to HyperCard's structure. Furthermore, the ability to integrate Quicktime meant that the focus of the course, i.e., children's language, could be illustrated along with the process.

Based upon the above rationale, the objectives for the integrated course were: 1) to have students demonstrate knowledge of the course content; 2) to apply the knowledge base to a "real life" problem; and 3) to use technology to create a usable future data base and to make the course content dynamic. The following is a description of the major course components, and how they fit together.

Initial understanding of normal language development is a prerequisite to being able to evaluate children's linguistic competence; to know if and how much a child's language is delayed; and finally to be able to determine what skills would appropriately be targeted for instruction. Hence, the students' first task was to develop a Glossary (first two cards in the HyperCard stack, Fig. 1)

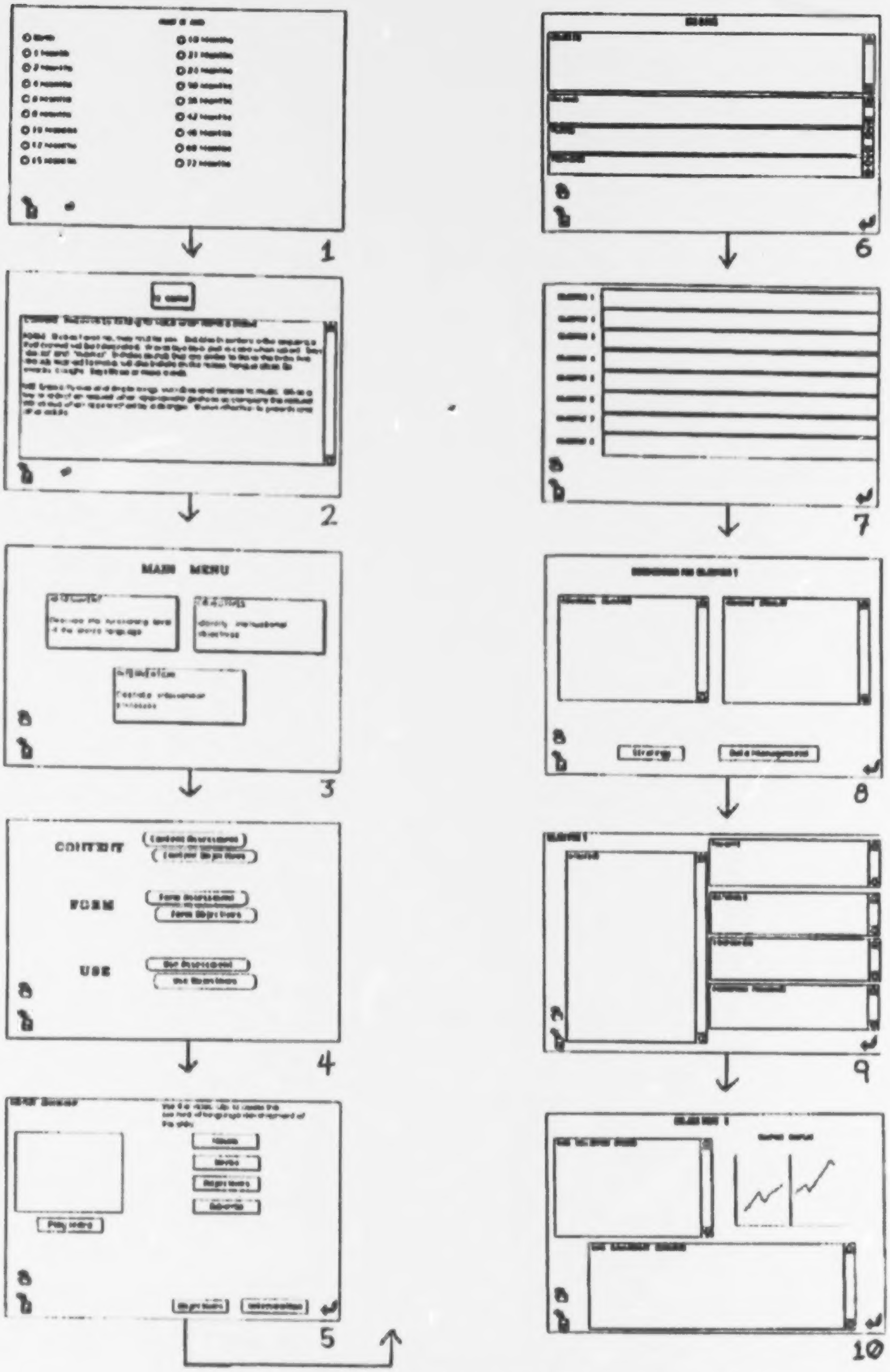
1
2
MAIN MENU
3
CONTENT
FORM
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Figure 1. Sample of Language Stack in HyperCArd

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which defined the normal linguistic skills of children at each stage of development from birth to age five. After the glossary was completed, students could press a "button" for any age, and be reminded of the expected abilities of children. For example, by pressing "2 months," students would find that an infant would have differentiated crying, smiles, quiets when held, shows recognition of mother, and so on.

All students were assigned a preschool age child who had a language delay to serve as the basis for their project. Once the glossary was completed, the students entered observational data for the child Assessment section (cards 3, 4, and 5, Fig. 1) of the HyperCard stack. The child assessment was divided into several components of language, and students were expected to be able to provide a comprehensive description of their child's verbal and nonverbal language skills. These data were gathered through multiple observations of the child in the home. Moreover, students simultaneously collected samples of children's language skills on videotape. This videotape was reviewed to isolate illustrative samples of each child's language abilities. Snippets of the videotape were then entered into the HyperCard stack as QuickTime movies.

Once children's present levels of language were entered, students needed to be able to identify what language targets would be appropriate for instruction. Instructional Objectives (card 7, Fig. 1) were then written in the HyperCard stack for each of the areas of language assessed. Objectives for a particular linguistic area (e.g., articulation of the sounds of language) were directly linked to the assessment cards for that area through the use of buttons, so that the students could move through the stack in logical progression.

Finally, students' needed to complete the process by identifying appropriate Intervention methods (cards 8, 9, and 10, Fig. 1) which might be used to teach aforementioned objectives. The intervention strategies were designed students by using curriculum content, and included scripting of teaching methods, materials, reinforcers, correction procedures, and data management. Again, intervention protocols were linked to their respective objectives in other parts of the HyperCard stack through buttons (Fig. 2).

Integration of Technology

The process of integrating the knowledge base through the computer project involves several steps. First, students needed to develop an understanding of the terminology and principles presented in the text. To accomplish this, traditional procedures were used to introduce content before each stage of application. Additionally, a comprehensive set of study questions accompanied the required reading from the text. Students were required to complete the study questions for submission, along with the completed computer project. Electronic technology, which included use of Macintosh computers, video recorders, and HyperCard, Adobe Illustrator, and Quicktime software was taught in stages, as the need to implement the technology arose throughout the course. Always, these electronic applications were taught while simultaneously illustrating utility to the Language Project — never in isolation. For example, HyperCard was introduced first in two one-hour sessions, as students began to develop the glossary. Finally, students were able to build a comprehensive illustrated data base on the computer by combining the aforementioned knowledge base in language, with their new skills in computer application.

Project Outcomes

Teaching two sets of skills together, as in this project (language intervention for young children and electronic technology), illustrated the efficiency of integrated

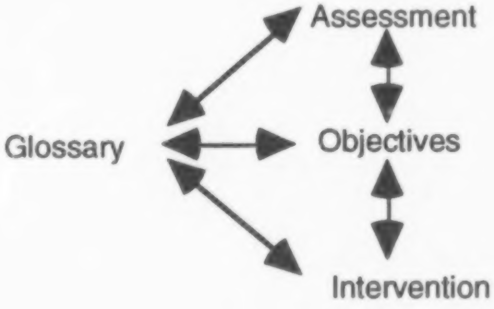

Figure 2. Relationship between major components of HyperCard stack.

instruction of technology. The project described above yielded information which might be used to make decisions regarding future use. Learning to apply course content from the language class and concomitantly mastering complex computer software for educational purposes were the obvious immediate benefits of the collaborative effort. Evaluation of student programs revealed that they had learned to utilize the major Language intervention techniques with greater generality and confidence than that of students from past Language classes. Moreover, students learned to use the computer systems with relatively little additional effort, beyond that required to learn the course content. Thus, teaching both skills concurrently increased the functionality and efficiency of the course.

Likewise, longitudinal benefits are likely to accrue from teaching this course in the manner described. First, the data base created by students in the present course represents the beginning of a comprehensive bank of knowledge which will be added to by each subsequent group of students. This data base can be easily transferred to the students, so that they will leave the course with multiple examples of child language assessment, and probable intervention strategies which might be adapted for children with similar linguistic needs. A second direct outcome has been the transference of computer technology to other courses. For example, the non-computer professor was able to teach students in a second special education course to use HyperCard to create multi-stage decision making programs. This transference of computer technology illustrates the potential "snowball" effect of integrating computer technology into higher education courses.

While overall positively evaluated, the project described herein also revealed weaknesses in planning which might be avoided by the authors in hindsight. The following recommendations are a result of post hoc analysis of the project.

1. In the present project, students were required to turn in the entire project at the end of the course, with only one opportunity for formal feedback. Frustration from lack of feedback, and student procrastination resulted. The latter was especially problematic when students failed to apply computer skills immediately, and often required reteaching of skills. To avoid such problems, completion of subcomponents should be scheduled on a weekly basis.
2. Students revealed that they had not solidly mastered the course content before being asked to apply knowledge to their projects. In some way, it may be necessary to evaluate the status of students' mastery of content (e.g., quizzes, written applications, or discussion of study questions) before expecting application.
3. Because this was a massive project, involving stacks of 75-100 cards, students indicated that they could not visualize the "big picture" until well into the project. Hence, providing a sample completed stack, both on the computer as well as hard copy, would have given students a greater sense of direction.
4. It may be that extended class time should be built into courses to accommodate students' needs for computer troubleshooting. For example, a one hour per week lab might be set aside for students to access expert assistance on computer applications, with traditional class time reserved for concentration on course content.

Future Directions

While this course served as pilot for integrated courses in higher education, it set the occasion for immediate replication. Other faculty, observing the immediate and spin-off benefits of Language-Computers project, have already requested the opportunity for future assistance. For this course and others that follow, improved computer enhancement systems will be explored. For example, it became clear early that the video clips of young children which were inserted into HyperCard through Quicktime would require so much memory that they would not be practical. Moreover, very expensive and sophisticated computer hardware is required to create and run such an integrated program—not commonly found in schools today. In fact, the time required to learn to use Quicktime, as compared to the functional utility of the program rendered the video clips little more than divergent gimmick. A more promising avenue for merging computers with video technology is to integrate HyperCard with laser disc systems. The prospect of such improvements to integrated courses increases the likelihood that students will become proficient learners of both academic course content and computer application.

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Incorporating CD-ROM technology into the curriculum

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Date: 1966
Location: Any elementary school, USA
Subject: Pat, a typical elementary school student
Assignment: Report on the digestive system

Pat, along with the other students in the class, is escorted to the library. Rushing to the one set of World Book encyclopedia, Pat grabs the D encyclopedia. Looking up 'digestive system', he begins to copy the first sentences onto his notebook paper. "This'll be a great report!", Pat comments to his seatmate and continues to copy the information from the encyclopedia. When he has finished, Pat goes home and neatly re-writes the report he has copied from the encyclopedia. As an added touch (and using 20 of the 64 colors in his crayon box), Pat draws an intricate labeled diagram of the stomach and its parts. "This'll be an A for sure!"

Date: 1993
Location: Any elementary school, USA
Subject: Mary, a typical elementary school student
Assignment: Report on the digestive system

Mary, along with the other students in the class, is escorted to the Media Center. Rushing to the one set of World Book encyclopedia, Mary grabs the D encyclopedia. Looking up 'digestive system', she begins to copy the first sentences onto her notebook paper. "This'll be a great report!", Mary comments to her seatmate and continues to copy the information from the encyclopedia. When she has finished, Mary goes to the computer lab and neatly word processes the report she has copied from the encyclopedia. As an added touch (and using the hand scanner located in the lab), Pat scans an intricate labeled diagram of the digestive system and its parts. "This'll be an A for sure!"

A New Beginning

As recently as 1989, CD-ROM technology was being touted as having "its greatest potential in library media centers when students are seeking printed information" (Langhorne, Donham, Gross, Rehmke, 1989, p.191). The limitations of having a medium primarily dedicated to 'written text' were offered as reasons for basing CD-ROM in the media area. However, in a span of only a few years, CD-ROM technology has developed and is continuing to develop into a tool which should be integrated into the classroom, both as a resource and as a teaching tool. Just as many advocates of educational technology are recommending removing computers from one centralized lab, CD-ROM technology should be available, not only in the school media center, but for use in the classroom. The variety of subjects available in CD-ROM format and the continued improvement of the interface between user and information mandates that we, as educators, investigate the use of this technology in our classes. This article will focus on three exemplary CD-ROMs and the benefits and potential inherent in each.

The *New Grolier Multimedia Encyclopedia* provides a basis from which to examine CD-ROM. An entire set of encyclopedia are contained on one CD-ROM. The combination of text, pictures, sound and QuickTime movies provide a valuable resource for use in the classroom. Information can be located through the use of keywords, which provides for an exhaustive search of the entire encyclopedia. Therefore, when a student is looking for 'astronauts', not only will the main article about astronauts will be retrieved, but any article which contains the word 'astronaut' can also be viewed. (The days of using only one encyclopedia can now be in the past. However, this still may not end the days of students copying the opening paragraphs of an article. Some things may never change!) The ability to conduct Boolean searches (utilizing delimiters such as *and, or* and *with*) also increases the potential usefulness of this CD-ROM.

This upgraded edition of the Grolier's encyclopedia is further enhanced through the use of QuickTime movies to display information. In addition to sound (such as a section of Martin Luther King's 'I have a dream' speech and musical instruments) and illustrations (various maps, photographs, and graphics), the user has video sequences available. This combination of articles, images, maps, graphics, sound, music, speech, charts and diagrams in conjunction with QuickTime video images provides a most beneficial tool for use in the classroom. Any educator who utilizes encyclopedia as part of their student's research tools and those who have previously regarded the encyclopedia as a 'grab a book and copy a paragraph or tool' type tool should definitely investigate the power and the potential for this tool. Note: A similar CD-ROM, *Compton's MultiMedia Encyclopedia*, is also available. The Grolier's CD-ROM, however, is often packaged as a bundle with the purchase of a CD-ROM player.

If you are looking for a CD-ROM that is both educational and fun, *Just Grandma and Me* will fit the bill. One of the first of a series of Living Books from Brøderbund, *Just Grandma and Me* is based upon the Little Critter story from Mercer Mayer. Not only can the student have the story read to them (in either English, Spanish or Japanese), but the student can interact with the story. Click on Little Critter or Grandma and watch what happens. Click on the mailbox and see what jumps out. As the story progresses, the characters in the book are 'animated' and the action follows along with the storyline of the book. If it's too windy in the story, watch Little Critter blown away with the umbrella. There are only two drawbacks to the product: First, it takes approximately ten seconds to turn each page of the book. This is due to the enormous amount of material being loaded from the CD-ROM. (It may also be due to the fact that I have one of the slowest CD-ROM players in the world!) Children do not seem to find this distracting, however- especially since the actual book is in the package. Secondly, you my spend so much time with *Just Grandma and Me* that your students won't get a chance to use it!

For the older student, and for anyone interested in classical music, *The Orchestra* CD-ROM from Warner is a must have. One of the Audio Note series CD-ROMs, *The Orchestra* utilizes Benjamin Britten's 'Young Persons' Guide to the Orchestra' to teach about the various instruments of the orchestra. In addition, the HyperCard software which is on the CD-ROM provides: musical notation of every melody, information about the various instruments of the orchestra, additional audio musical examples, a quiz on the various instruments of the orchestra, and an orchestration lab in which you determine which instruments will perform the tune 'Greensleeves'.

What makes each of these CD-ROMs exemplary is the extent to which the developers have incorporated both ease of use and educational applicability into each program. The software for *The Orchestra* highlights each measure of musical notation as it is performed. *Just Grandma and Me* not only provides a program which could easily be used by a young child, but also allows the user to become actively involved with the program. The 'What If' and 'What do you think will happen now?' factors are strongly evident throughout the program. The *New Grolier Multimedia Encyclopedia* is designed with student research in mind, combining the benefits of a full-range of encyclopedic information in combination with hypermedia in order to more fully understand a subject. The potential for classroom use for each of these CD-ROMs (as well as many others) is virtually unlimited. As with any technology, however, the potential for use is tempered with the knowledge that these are only tools and should be utilized to enhance the learning process. Each of these CD-ROMs contains an inordinant amount of information and 'stuff' which could overwhelm some students. Serious thought must be given as how and when to introduce this medium and when to allow the student to begin exploration on their own. We, as educators, must become familiar with this technology in order that we may provide guidance and vision as to their use. Fortunately, with the CD-ROMs discussed, and with many others that are becoming available, the developers have incorporated both ease of use and sound educational benefits into each program. It is up to each of us to put these products to best educational use.

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Putting together the multimedia electronic classroom

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University Indianapolis

Introduction

One of the major differences between the conventional classroom and the "electronic"classroom is in the type and quantity of media available. In the conventional classroom,media tend to be limited to the chalkboard and the overhead transparency projector. In the electronic classroom, the range of media available increases significantly. This increase means the inclusion of equipment such as the person computer, laser disc player, video projector, CD ROM player, stereo sound system, and the like. That many teacher stay with conventional teaching tools attests to their familiarity and ease of use. The blackboard is understandably easy to use, while learning to operate the overhead transparency can be mastered by a novice without need for a user's manual—there are just two switches to operate, the power switch and the focus knob. In the multimedia electronic classroom, there are several pieces of electronic equipment, each with dozens of control knobs and switches. For a task such as presenting a video image on a classroom screen, several pieces of equipment must be sequentially powered and adjusted, such as video projection equipment, computer, video playback device, room lighting, sound amplification and so on. The operation of this equipment can mandate a lengthy training session. A proposition most teachers are not likely to look forward to.

In order to reduce such problems and difficulties at the control and interface level of the electronic classroom, a new piece of technology is needed—the Human-Technology Interface (HTI) system. Such a dedicated computer system is especially designed to simplify interface between teacher and technology in the classroom. For instance, when the teacher wants to display the computer image on a large screen, they merely would touch the computer symbol, or icon on a touch sensitive display panel, and all relevant devices would be automatically activated while necessary adjustments are made in order to project the computer image onto the screen. All these operations are performed while kept in the background. By using an HTI system, the teacher could then concentrate on teaching without having to deal with such interruptions as pressing switches and adjusting knobs located throughout a classroom.

Characteristic of an Electronic Classroom

Electronic classroom can be defined as a teaching environment where a variety of electronic media or instruction tools are available to support teaching. This includes a selection of video projection equipment or video monitors, video playback and computer equipment, sound system electronic link to outside multimedia resources, and the like.

Characteristics of electronic classrooms could be addressed from different perspectives, such as the technology and its capabilities, ergonomics for ease of use, architectural and environmental design, instruction, and the like. Architect, media technologist, engineers,—all have their own unique expertise in design and development of electronic classrooms. Each group tries to define and set the requirements from their own perspectives. Building architects tend to pay more attention to the room in infrastructure and be pay more attention to the interior design of the environment. Engineers and media people, on the other hand, are interested in the quality of equipment, wires and signal. All looking at the "design of the classroom" but only from their own perspective.

Jafari (1991) has identified five requirements for the electronic classroom. These requirements can be used to set direction and objectives for the electronic classroom design team. These include the following characteristics:

Be easy to operate. Operation of various technologies during a lecture should be simple and straightforward. AL equipment should be user-controlled from the front of the classroom, which is where the instructor prefers to lecture and can monitor audience response.

Be simply and quickly learned. It should take little time and require few directions to learn how to operate the various classroom technologies. Too often a faculty member must spend sever hours or sometimes days learning how to utilize technologies in a high- tech classroom. This e effort has been resisted by many who have previously utilized conventional technology (overhead and chalkboard) for many years.

Be instantly available. The instructor should be able to activate any readily available technology whenever needed it is needed with minimal preparation time (i.e., technology should be ready and operable in mere seconds).

Be a reliable system. Classroom technology hardware should be extremely reliable so that an instructor need not hesitate to design lectures which regularly incorporate the use of technology. Otherwise the technology win lose out to the chalkboard which always "works".

Be able to provide features which surpass traditional technologies. Such technology as the computer and video projection should, with the adequate hardware so will be capable of presenting material (such as graphs and charts to be displayed on a screen) better than does the conventional media, such as the overhead projector.

In order to meet the above requirements, electronic classroom design teams should pay special attention to the design of classroom environment, selection of technology equipment and to issues that effect the quality of ergonomics. These are discussed in this paper.

What is a HTI system as it applies to electronic classroom?

A classroom human-technology interface system is a medium through which the teacher exercises control over a variety of audio, visual, or multimedia equipment. (See figure l) It automates and simplifies the use of instructional technology in the classroom. A HTI system consists of two major components, the teacher-HTI system interface component and the HTI system-technology interface component. The teacher interface component is most commonly a touch sensitive display panel. In this instance, the touch screen is installed led on a podium in front of the classroom. By touching a display word or icon on the touch screen panel, the teacher can select, activate and control a variety of equipment. The HTI system-technology interface component consists of several interface computer circuits, or boards which connect electronically or optic optically to a variety of audio, video, computer, lighting, and other devices located throughout the classroom. For example, an infrared signal can be generated by the HTI system to signal a VCR to play, pause, stop and so on. A RS232 signal could be generated by the HTI system to search a frame on a laser video disc.

Several HTI systems are currently available on the market, including those developed by Crestron, Elmo, Sony, and the Technology Access Governor, or the TAG system research and developed at IUPUI Elmore, 1991).

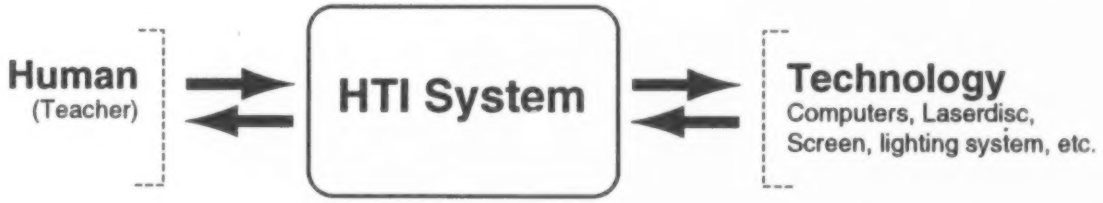

Figure 1. Human Technology Interface System

An HTI system can play a major role in ease of use, simplicity and reliability of technologies in the classroom (Jafari, 1992).

Design Paradigms

In recent years, many educational institutions have invested in the upgrade of existing classrooms to create electronic, or multimedia electronic classrooms. Despite their initial promise, most have had only limited success. If there is blame to be meted out, then a likely place to start is with the building architect or technology vendors. They are likely unaware of the needs of teachers and the use of technology in the classroom along with ergonomic design principles as they pertain to Human-Computer Interface (HCI) issues. In most instances, the design model is based on building the facility first, and then the matter of technology integration. This model has been based on receiving input from technology vendors and engineers while ignoring or disregarding the input of teachers, educational specialists and experts in HCI.

Kent Norman (1991) discusses three paradigms of design for HCI which can be directly applied to classroom technology design. They are identified as follows: ergonomics last, ergonomics first, d parallel/interactive/ iterative iterative design. It would seem that the design of most classrooms and learning environments today feed into the category of "ergonomics last", with ergonomic considerations, such as the relationship between technology and user, taken only as an a after thought to the design. Hence, this is probably why most of the classroom renovation projects have not lived up to their original expectations. By the same token, ergonomics simply for ergonomics' sake is not the answer, either. Adding extra controls and system capabilities without first gathering the whole picture, starting with the user, is also not the answer. Design should proceed under the guidance of an media technologist/consultant while also including the mutual considerations and feedback of teachers. A course of action that would be included under Norman's parallel/ interacting/iterative iterative'' paradigm (see Figure 2). Under such a plan, building architects who design classrooms need to consider such design parameters as size of screen, type and orientation of lighting system, seating arrangement, interface issues, and the like. In the past, lack of consideration for these issues did not cause a major problem in the design of conventional classrooms since the chalkboard was the dominate medium.

Characteristics of the human (teacher)

Classroom design teams must first consider the teacher. Teachers vary in technical skill, background, knowledge and interest. These differences determine their performance, as processing can vary according to their perception skills, level of attention, memory functioning, and motor skills. User characteristics, as they apply to the electronic classroom, can be grouped into three types:

Knowledge Characteristics. Teachers vary in terms of their knowledge about technology. Members of faculty in engineering and the sciences tend to have more technical knowledge about computers and how they function than those in education or liberal arts. Because of their training and day to-day research activity, faculty members in scientific fields are more likely to be comfortable operating devices such as VCRs, sound equipment and mechanical switches (Heywood & Norman, 1988).

Cognitive Characteristics. Teachers, like anyone else, vary in their ability to make decisions, solve problems, and perform various mental tasks. For instance, pulling a projection screen down and adjusting it so that a keystone corrected position is found can be a difficult task for some teachers. Having to deal with the business of instructing white, at the same time, being forced to cope with what can be unfamiliar or simply unmastered technology can be a burden too much to ask.

Skill Characteristics. Teachers vary in their ability to apply educational technologies. Some have extensive experience in the use of computers and may even have developed sophisticated multimedia programs using complicated authoring so software. Others may be without even basic computer literacy skills. Surveys indicate "mild to severe discomfort" among people using computer ranging between 10 to 40 percent of the adult population. Rosen, et al, 1990).

Characteristics and capabilities of the technologies

Today, the challenge of selecting a VCR or a computer is difficult. There are hundred of different brands and models, each different from the other while offering a broad range of features. Some of these features may be unfamiliar to some intended users, particularly novices. Selecting equipment that offers needed features is one thing. Finding different equipment that can interface with each other to form a functional multimedia system is quite another. Therefore, it becomes necessary to evaluate each individual piece of technology against the following characteristic factors:

Interface Characteristics. Is the equipment selected operable by remote control or a signal from a HTI system? For instance, can a laser disc be remotely controlled by an external device. Can it be controlled by two external hosts, a PC and a HTI system? Can the motorized projection screen be remotely controlled? Can the lighting and sound systems be remotely controlled?

Functional Characteristics. Does the equipment support necessary functions needed for various applications? Can the video projector show a high resolution image generated by a SUN workstation? Can it automatic optically synchronized and converge to a VGA signal? Can it be controlled by a remote device or an H I system?

Technical Characteristics. Does the system have the technical capabilities to be expanded to support future technology renovation and upgrade? Can different parts of the technology be integrated?

Other Characteristics. How reliable is the system? How quickly y could it be repaired, or replaced, in the case of technological obsolescence or upgrade? A d more...

Electronic Classroom Design Model

Design of the electronic classroom should function on a reciprocal basis, with interaction among expert and fun participation and input from representative members off faculty. Figure 2 illustrates this process, showing it as an alternative to traditional models by emphasizing a dynamically reciprocal relationship between technology users, namely teachers, and building architects and media technology experts. It is based on the principles of Norman's (1991) parallel /interactive design model. Within this model, the faculty provides information concerning their use of technology in the classroom, including (using which technology to do what for what purpose), their preferences and teaching format (e.g. simultaneous use of one projection screen and one marker board or two projection screens and no simultaneous marker board or maybe one projection screen used with one live experiment). Such information is in turn should be used to form the basis to specify appropriate types of technology, classroom design environment, wiring system, and overall design of the HTI system.

In this model, the media technologist/consultant team plays a major role. They are the technology experts. They know what is available on market and are able to identify the advantages as well as limitations of two similar technologies as they are applied to classroom technology.

Some media technologist/consultant may be familiar with one type of technology and less familiar with another. Consequently, certain biases over the under-specification or over-specification of various technologies used in the classroom may exist. For instance, a media technologies consultant firm whom are specialized in the area of acoustic and audio en engineering are inclined to over emphasize the use of audio based systems and room acoustic treatment. Another firm that has a broadcasting background may promote the use of expensive broadcast quality equipment which may not be needed in electronic classroom applications.

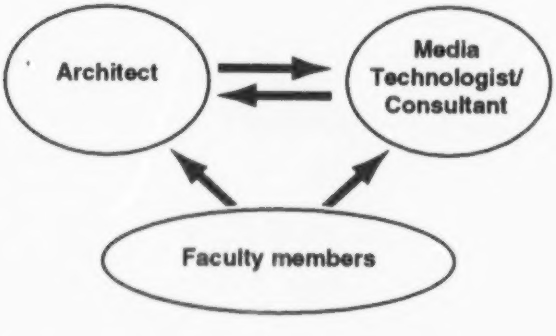

Figure 2. Electronic classroom design model

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Mindful hypermedia: Teachers as authors

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A Context for Hypermedia

Hypermedia systems are becoming more prevalent, accessible and user friendly. A variety of positive claims have been voiced about the educational impact of such systems (see review by Nelson & Palumbo, 1992). Because of the relatively easy load of programming these systems can be used by teachers.

Teachers are described in the educational technology literature in a wide range of technological and design competence: from struggling to become computer literate (Alessi & Trollip, 1991) to "instructional gurus" (Venezky & Osin, 1991). But the option of teachers preparing their own materials has always been positively viewed even prior to the computer era. Rather than using standardized "teacher-proof" materials, more locally authentic, individualized or unique materials are likely to develop. Current authors expecting teachers to jump into the computerized environment, perceive teachers to be active, from modifications of open courseware (Rivera & Haddock, 1992) up to full participation in the creation of multimedia environments (Falk & Carlson, 1992).

A recent movement in education called Total Quality Management (TQM) is also shifting attention into quality control in the small educational organization (Sztajn, 1992).

> Our best products cannot be mass-produced. Each has to be unique, and it is precisely this uniqueness and its endless range of possibilities that makes it valuable. The *education is art and school is a handmade process metaphor* might initially seem to be an expensive process. Nevertheless, our society can afford it if there exists a real desire to make profound changes in the status quo. (Sztajn, 1992, p.37)

This quality of uniqueness may evolve if individual teachers or teams of teachers will be involved in the development of locally based materials; hypermedia is the best tool so far for these efforts.

This paper is highlighting the complexity of the task of training teachers to become authors. This training should include: learning theory, awareness of structure of disciplines, instructional design models and potentials of hypermedia systems. Initial instruction in these areas is intended to bring teachers to a *level of understanding*. Then more instruction is needed to ensure a *transfer level*, when teachers are appropriately using what they have learned in their first authoring project. This transfer is expected to be mindful (Perkins & Salomon, 1988), so design ideas are implemented in new tools rather than a random display of attractive screens...

The complexity of training teachers to be hypermedia authors, with a major limitation on training time (see project description), requires to prioritize the kinds of desirable training and strategies employed for training. Looking at the transfer literature (Gick & Holyoak, 1987) seems to be productive in terms of the general strategies to be employed in this instructional sequence. Determinants of transfer range from number and variability of examples, conditions of encoding, prior knowledge and more.

Since the teachers have to comprehend the information presented, prior to transfer to a "real" project, one should adopt a *constructivist* view of learning and memory (Royer, 1986). Comprehension of the information should be defined as a divergent task, where teachers are constructing meaning by interpreting a message in light of their *own knowledge*.

Using hypermedia as the major tool for authoring may produce instructional materials of different modes: Knowledge Presentation, Knowledge Representation and Knowledge Construction (Nelson and Palumbo, 1992). However using new tools does not preclude the need for classic instructional design skills: task analysis and flow charting. The task analysis should reflect learning theory, teachable tasks and a view of the subject matter. The flow chart should reflect comprehension of the medium potential and preferred instructional models.

Such complex teacher education endeavors are best studied using naturalistic inquiry methods. Teachers receive a variety of "inputs" and produce two complex "outputs" that are impossible to quantify: a hypermedia learning material and a new understanding about the multivariable process of the development of a CAI program. The need for more naturalistic inquiry in computer-based instruction has already been recognized (Neuman, 1989).

The following is a first phase report of a naturalistic inquiry into the process of teacher training in hypermedia type CAI.

Project Description

A CourseWare Development graduate course is being offered in West Michigan to teachers pursuing a masters in educational technology. Initial instruction in instructional design has been classroom based through lecture and discussions. The teaching method used had an emphasis on principles and not details- a *conceptual* approach to teaching (Javetz, 1991). The main software tool, an hypermedia system TOOLBOOK is being taught by the same instructor in the computer laboratory. Some teachers preferred to create their final projects with HyperCard due to the platform available at their school, and they were allowed to do so. Another communication channel was opened, when students began writing a journal entry in every class, and saving it as a file on disk. The instructor read their journals and entered relevant answers. The purpose of the journal activities was to enhance comprehension and transfer, while supporting creativity and divergent perceptions.

The journals also reflected affective processes. The teachers were overwhelmed by the complexity of the task, and the instructor acknowledged their feelings and directed them to positive avenues, namely, concentrating on one sub task at a time—the one they preferred to do first.

The emphasis on comprehension and transfer was expected to pay off in the final task as well as in the course sub tasks. The sequence of tasks required by this course were: Treatment Paper (cited research about variables of interest), Task Analysis (applying Gagne's terminology and learning hierarchies to a subject matter of choice), Flow Chart (for an hypermedia tool, so it does not have to be sequential), and Program Sample (where all previous sub tasks can be implemented).

One can see that teacher training in this context was a combination of old and new ideas in instructional design. In every stage, a "classic" idea was introduced with its old manifestations. Then new models were introduced to accommodate new knowledge in cognitive psychology and in more versatile computer tools. A case in point is the Flow Chart stage. Its classic manifestations were introduced (see for example Alessi & Trollip, 1991, Hannafin, 1988, and Figure 1), however more relevant models were suggested too. Flexible guidance in a linear environment (Figure 2), a structured database using clusters (Figure 3), and a hierarchical network (Figure 4) were introduced as part of a continuum of possibilities. The models varied as more or less appropriate for the kinds of knowledge represented. Also, navigational patterns and amounts of learner control were described as limited, pending on learner's prior knowledge and metacognitive skills.

In the first phase of the study, student journals were analyzed as the main source for tapping into the conceptual development of the teachers. Did they achieve a new understanding about the development of CAI materials? Did they appreciate the process they have been through? Did they *transfer* at least some of the ideas taught and make conscious design decisions in their new programs?

Analysis and Results

Since the journals were an informal , open-ended tool, the teachers keyed into the word processor, Word for Windows, every topic of concern, be it personal or professional. The instructor responded to the issues, and sometimes posed direct questions in order to encourage thinking in a certain direction.

Generally speaking, the text material (the journals) can be analyzed to at least six theme areas: Problems (that teachers are aware of), Hypermedia (attitudes and appreciation of), Importance of the design procedures

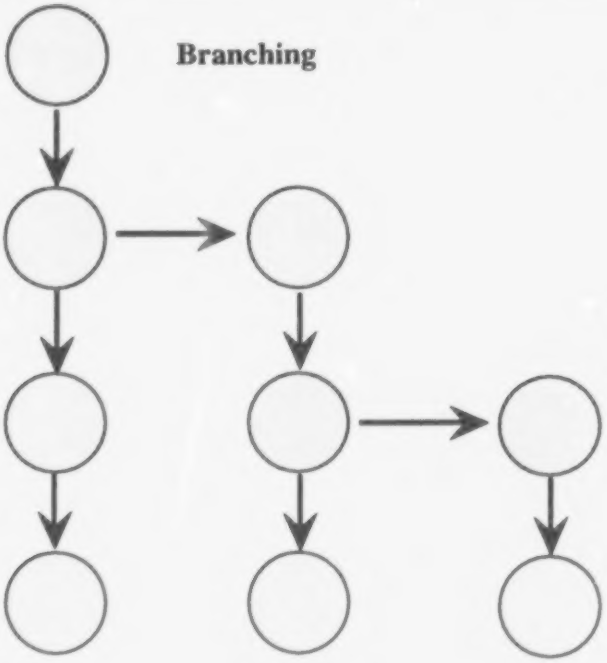

Figure 1

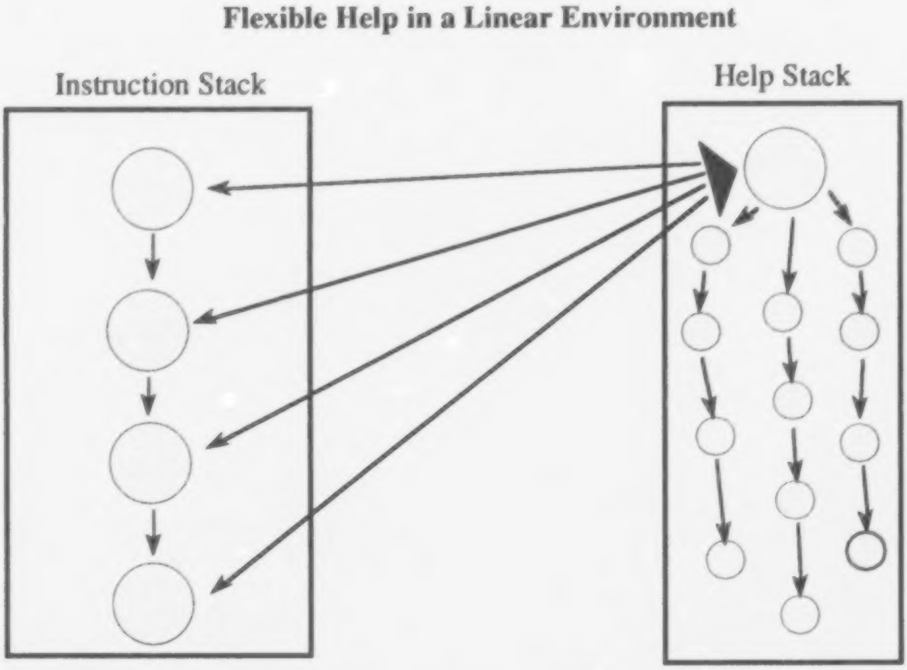
Flexible Help in a Linear Environment
Instruction Stack
Help Stack

Figure 2

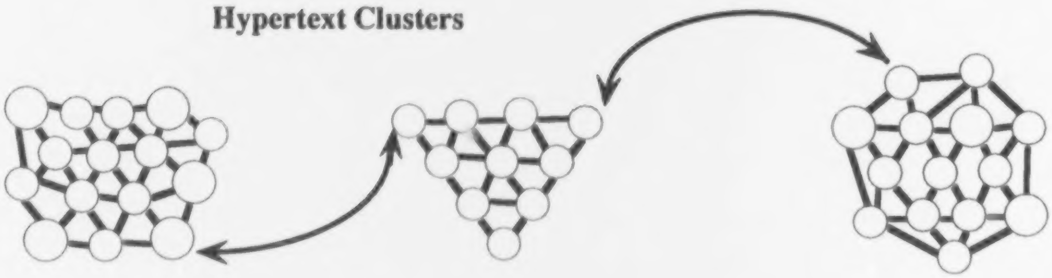
Hypertext Clusters

Figure 3

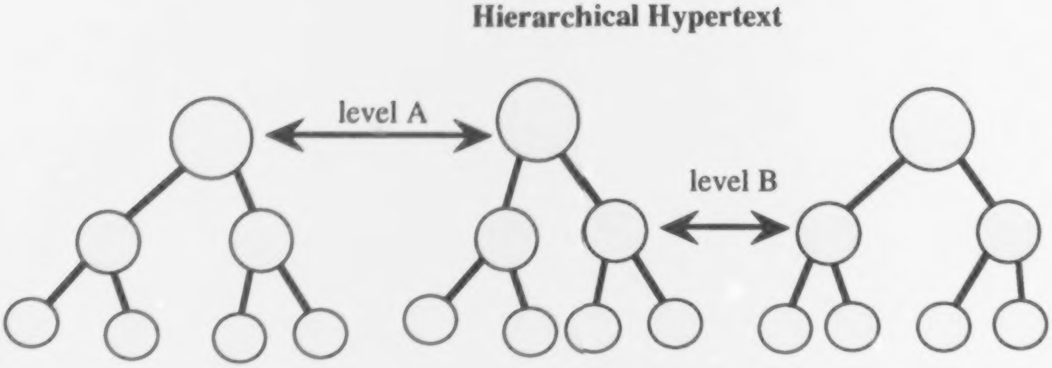
Hierarchical Hypertext
level A
level B

Figure 4

(especially task analysis and flow chart), Awareness of their students' needs, Reaction to the team work done in the class, and Decisions about design (that they have made for their own program).

Problems

In each category, various excerpts are provided. In the problem category, teachers expressed an array of problems. Some of them relate to what is happening in the schools:

> It is kind of frustrating at my school because many of the teachers don't see the need for technology in education, so it is hard to get them to learn how to use even the Apple //e's that we have.(B.H.)

Some are related to a state of confusion when starting a journey into a new discipline:

> I think there is an adequate rapport. I don't believe your expectations/ requirements for special assignments are always clearly understood.(J.G.)

and some still ponder if instructional design is a research based authoritative source or maybe creating a learning material is just a question of opinion:

> I think your rapport with the students has been quite good, though at times your view may very well be the generally accepted one. You may give the impression that your view is the only acceptable one. Admittedly, this is often when we are discussing items which are of special interest to you, and of which you do have greater knowledge than us.(T.H.)

Hypermedia

Hypermedia systems were unanimously well-viewed, and teachers felt even a sense of power by just learning one or more of these systems.

> At any rate, I am excited to enter the world of hypermania. [J.G.].

> Hypertext/Hypermedia is a useful tool to create professional looking programs. Before this course I had only heard of Hypermedia, and now I am really jumping into it. I don't think Hypermedia is practical at this point in time because of the time involved in producing a program (at least until I become more proficient at it). I think I would either spend my time looking for an existing program that someone else has produced, or use some other means of teaching something(B.H.).

> Coming into this course, I had a sense of what hypermedia/hypertext was all about. I had no idea how everything was connected. Now I understand how it works. I have still need to learn how specifically to make the program work (i.e. develop a program using Toolbook or MacIntosh Hypercard). This will come with practice and experience (and the user's manual.)(J.G.)

> I think hypermedia/text is highly relevant. More and more, I am hearing about hypermedia in the schools. Students are being asked to create a hypertext/ HyperCard program rather than a simple written report. Shouldn't the teacher have the same capability? In addition to knowing how hypertext works, I think it's great to have the knowledge to put a CAI together. At the very least, I have gained great respect for educational software producers.(J.G.)

Importance of Design Procedures

Teachers in this course received a new awareness of the importance of instructional design procedures. Some accepted them in a more passive mode ("we follow instructions") like:

> As for how we will use the task analysis we will have to be sure to cover all the concepts described in it. There will be very few concrete concepts for the students so we will have to provide basic instruction in most of the concepts. We are planning on having a tutorial section for each different type of graph. This will have the basics of how to "read", "I.D.", and "create" each type. This will also include the vocabulary.(J.S.)

Some internalized and saw different components and their interrelationships, like:

> The task analysis really started us thinking about the levels and relationships of the information we were presenting to the students. Understanding and isolating the verbal information stressed the need to be sure the students have a clear understanding of the vocabulary we are using. Charting the intellectual skills helped clarify what items were defined concepts, concrete concepts, or rules.(K.K)

and others saw these procedures also as a communication tool, to express their ideas, and receive professional recognition.

What was the purpose of the flow chart?

It helps me better visualize where I'm headed with my program. Although, my screens are not done, they're

> still in the development stage, I can see lots of room for expansion. How did I envision my project before and after the flow chart? Before the flow chart I felt kinda like a pioneer. Nobody (and I mean NOBODY) has any vision for what I am doing (or want to do) in H. With the flow chart showing me direction, and the research I've done to support it I'm beginning to see a horizon-bigger than I had envisioned. [A.V.]

Awareness of their Students' Needs

It is important to promote teacher awareness of student needs. Teachers that expressed this understanding (not all of them) were already applying the new knowledge to their work environment, both in a computer and non-computer context.

> I work in Northern Michigan throughout the summer with the Pshawbestown Indian Reservation. My teaching certification and college major was in Environmental Science. I spend some of my time up north teaching Environmental Sciences. The Reservation has purchased Macintosh computers and it would be great to be able to bring to them a curriculum that is relevant to them in Environmental, Historical, Cultural as well as other areas.(R.Y.)

> As I approach the new school year, memories of the successes and difficulties of last year's student come to mind. In the area of science the fifth grade has five major areas of study. Within the animal unit the students had great difficult grasping the classification and characteristics of invertebrates. I would like to create a multimedia program to help the students form visual relationships among the groups of invertebrates and understand the characteristics of each group. (K.K.)

> One thing I have noticed quite often while subbing is that instruction oftentimes presents concepts without developing the knowledge necessary to understand the concepts. For example, articles are read and/or newscasts are shown on topics such as Bosnia. Students, for the most part do not even know where Bosnia is, let alone the "defined concept" of civil conflict. If teachers were to do task analyses on current event topics maybe students would understand more, or maybe teachers would realize how complicated (and beyond children) some topics are. [M.C.D.]

CAI—New View

CAI as an umbrella concept for any form of Computer Based Education was adopted with a new view about its current definition. Knowledge of how to create CAI (=instructional design) is appreciated as a contribution to teaching:

> During the past week I was able to get myself acquainted with the textbook and get an overview and historic perspective of CAI. We also read about some of the applications of CAI. The readings were very interesting and have started me thinking in a whole new area as to directions that I can go, in my development of some CAI for my particular teaching situation. I can see many challenges that lie ahead and I know that by facing them and achieving success in them will lead me to be a better teacher.(R.Y.)

as a complex process:

> I have gained greater understanding and respect for all that goes into the development of CAI programs from why certain "things" must be done and how to best achieve an effective CAI (from research, readings, class time). Admittedly, I still need to gain greater experience on the computer to actually create a product.(J.G.)

and as a tool in software evaluation:

> The more we learn about CAI the more disappointed I am with the programs that I have seen in the past. They, to say the least, were very poorly designed, at a low level, and very limited. With the continued improvement in computer speed and storage it seems that the quality of CAI should also improve at the same rate. I am very much looking forward to learning more about design and authoring.(T.D.)

Teamwork

The process of cooperative learning encouraged by the instructor was accepted by most teachers. Few still decided to work in groups of one. Most teachers expressed satisfaction from the team approach.

> I like working with a team and getting to know other classmates better. So often in a graduate course no one gets to know each other, but now I have some cohorts to call for help, encouragement, guidance, or ideas long after the course is over. (K.K.)

> I feel like I have learned a lot,. I've learned a lot through the help of other students.(A.V.)

while some were happy to work individually.

> The group of students seems to be individual and concentrating on their assignments. I am too busy in class myself to even be conscious of a group atmosphere.(R.Y.)

Effective Design

All teachers participating in the course wrote something about effective design. At least some of their program components were consciously designed:

Some of the elements that we used to facilitate learning are the following:

- Gaining attention: we used graphics of the animal on each introductory card. We also used video of the animals and sound to denote correct or incorrect answers on the quiz.
- Informing learner of lesson objectives: The beginning of the program lists the objectives the students need to master.
- A chart and a recorded voice reminds students of information they have learned before about animals, and where invertebrates fit into the animal kingdom.
- Presenting stimuli: the text bullets provide the information the students need about the new concept. A graphic of the animal appears in the center of the page with the information. The video also shows the animal in its natural environment.
- A quiz is provided in each category to gauge student progress. The students are informed and congratulated for a correct response and informed and sent back to the information they need for an incorrect response.(B.H.)

To facilitate learning, I expect to keep things simple, consistent, centered, and free of distracting elements. Where learner control is available, it will be largely graphic, simple, and consistent. Navigation clues will be based on simple graphics and color. Clues will be consistent between menu items and screens. I will try to gage times / repetitions such that the variety within a section will be sufficient to sustain interest.[B.Z.]

Discussion

Hypermedia systems and platforms hold a lot of promise to education (Megarry, 1988). Beyond the computing power, new program designs and display metaphors have to be created (See Figures 2, 3, & 4 above; Chiou, 1992; and Locatis, Letouneau, & Banvard, 1989).

Teachers are exposed to hypermedia systems as buzz words or with incidental manipulations of screens, clip art, fonts, and sound or video capabilities. This project documented the conceptual development and transfer that teachers can go through to become better teachers and more skilled users of hypermedia systems. Teacher education is still the most complicated but worthwhile process in the equation of hardware, software, students, and teachers. Teachers who are computer literate should further their education in instructional design and cognitive psychology and may become local leaders in the development of our new learning materials.

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Marketing schools through multimedia: How San Diego Magnet Schools "sell" themselves to the public using technology

Carol A. Kerney
San Diego City Schools

Why Market Schools?

Marketing your school is not something that teachers, student teachers, and teacher educators often think about. Why should we market our schools? A school isn't an insurance office, a car dealership, or a toy company.

Have you ever noticed how often newspapers and television news seem to focus on what is *wrong* with education? Does your school ever need to seek grant money or financial aid from business or organizations? Do you want the central office and the community to think well of your school? What happens if the movement toward schools of choice becomes more popular? How will you compete for students then? Is your school a magnet school and do you have to compete for students *now*?

Schools want parents, district administrators, and the community to understand and appreciate the good job they do. When we let the world know what is good about our schools, *we are marketing them.*

Magnet School Recruitment

Some of us must take a proactive attitude toward marketing. Magnet schools, for example, must actively attract nonresident students in order to reduce racial isolation. Recognizing this need, San Diego designed a position called recruitment resource teacher paid with special funding from the federal government. I have held that position since 1989, and in 1992 we hired yet a second person to work centrally with magnet school marketing. In addition, at the magnet schools, one of the principal duties of on-site magnet resource teachers is recruitment to their individual schools.

What do the magnet schools do to attract students? San Diego's magnet schools send out brochures and flyers, give presentations at target schools, man booths at community events, participate in the annual telemarketing campaign, and try to saturate a target neighborhood with articles in the local newspapers and flyers in local businesses.

Besides helping with these activities, at the central level we boost recruitment by:

- developing the Magnet Information Line (a voice mail system with information about each of the 46 magnet schools, eligibility requirements, transportation, etc.);
- designing billboards that advertise the magnet schools;
- publishing a newsletter that promotes the special programs in the magnet schools;
- creating training programs to help schools design their recruitment plans; and
- creating multimedia promotions.

How Do We Use Multimedia to Market the Magnet Schools?

Since June 1991 we have taken advantage of the particular strengths of multimedia to publicize our magnet schools. We define multimedia as combining live action video, animation, graphics, text, narration, and music into an integrated whole. Multimedia captures and holds attention, it has a modern look, it is a flexible production tool—all of which makes multimedia a great tool for marketing.

In our district we have used multimedia in our marketing efforts since 1991. We use multimedia in public service announcements, modular video, and interactive kiosks.

Public Service Announcements (PSAs)

Public service announcements are "commercials" that air free-of-charge on television and radio. San Diego has three television network affiliates and two major cable stations. Beginning in January 1992, we have aired PSAs about magnet schools on both cable channels and repeatedly on one network station. The 30-second PSAs have aired some 100 times.

I made the PSAs using the multimedia system that is detailed later in this paper. The basic visuals are computer-generated animation. Music and narration are added. The result is colorful, fast-moving commercials. The following paragraphs describe several PSAs.

The first two public service announcements to air were called "Check It Out!" and "Pick a Dream ." "Check It Out!" starts with the words "Check It Out" on a neutral background. A bold black check mark appears. The music grabs attention with a heavy beat and futuristic sound. Then the screen dissolves to the message, "San Diego City Schools Magnet Programs Give You Choices in Education" followed by a list of magnet programs. Finally, as the music builds to a crescendo, the check mark flashes on and we throw up the phone number of the Magnet Information Line.

"Pick a Dream" is softer. It asks people to consider what educational dreams they may hold for their children. First a white daisy "grows" across a shaded pink-and-rose background. Then one petal picks itself from the daisy and the words "Pick a Dream" appear. Next we say "San Diego City Schools Magnet Programs Make Your Child's Educational Dreams Come True." Then a bouquet of daisies pop up over the words which are replaced by an invitation to phone the Magnet Information Line.

The third PSA starts with the darkened skyline of a city at night. Suddenly a huge sun flares behind the skyline and the night sky melts to a glorious sunrise. Cheerful wake-up music plays behind "Light Up Your Life San Diego." "You Have Options in Education." Then "Magnet Programs " zoom up, "San Diego City Schools" flashes across the screen and the piece ends with the information line phone number.

PSA number four is different from the earlier three in that "Moi L'ecole " focuses on a specific school, Knox, our elementary French immersion magnet. The TV viewer sees a child's drawing of a school and hears a young girl's voice speaking French. The narrator, a fourth grade student at Knox, alternates French with English. During the PSA a child's drawing of a teacher appears and walks across the school yard. Next children's faces appear. The sun winks, the children smile, and the narrator concludes, "I love Knox!" The viewer is encouraged to find out about Knox and other magnet schools by calling the Magnet Information Line.

Modular Video

Video is a very effective marketing device. When a school's magnet resource teacher makes a recruitment visit to target schools, it is helpful to carry a video that describes the magnet school. When prospective parents and students visit the magnet school, a snappy video will inform and attract. What better way to sum up the school's mission? And video is a time traveler. It can show the students involved in activities that happened six months ago or on a field trip or during the school day even when the visitors tour after school hours.

San Diego City Schools has 46 magnet schools and at least 13 of those magnet schools need updated videos. The task of creating so many videos is monumental and far too much for the two people in our office to accomplish by ourselves. Therefore, we needed to come up with a method for us to partner with the magnet resource teachers to make recruitment videos.

We in our office know video production; magnet resource teachers at the schools know their schools. We need to make maximum use of everyone's expertise—in minimum time. Hence, the "modular video" concept. Modular video is a term we coined to describe how we plan to produce 13 videos over the next two years while still keeping up with our other duties and without going totally crazy. Here's the plan.

Step 1. My colleague Shirlee Rodriguez and I use the multimedia system to design and produce three video formats broken down into their modular parts. I'll give an example.

Our first prototype video features Fulton, an academics and athletics elementary magnet. The narrator in this 8 minute video is the school's mascot, a muscular fellow who is a human-like wildcat. The video combines action shots from the school with graphic overlays, animation (mostly of the wildcat in various athletic poses), music selections, and narration. The narration was recorded by an actor who volunteered to perform the wildcat voice.

To modularize the Fulton video, we break the video down into its component parts. Then we outline the "modules" on the computer, ie., the first 18 seconds is an introductory animation, the next 12 seconds show a live action exterior shot of the school, etc, until the whole video has been reduced to its parts.

Step 2. We have, in effect, outlined the script for the schools. Magnet resource teachers from each school visit our office and select one format for their video. The deliverable from that meeting is a list of camera shots that the magnet resource teacher must get at school and a list of graphics and animation that we will develop using the multimedia system.

Step 3. Scriptwriting is next. Teachers "fill in the blanks" in the modular script with information specific to their schools.

Step 4. The next step is for magnet resource teachers to capture the raw footage. They get videotaped shots of the exact scenes necessary to complete the modular video.

Step 5. Meanwhile, we create the graphics, animation, titles, and credits on the multimedia system.

Step 6. We select appropriate background music.

Step 7. We record the narration.

Step 8. Our final step is to use the multimedia system to edit together the video footage from the schools, graphics, animation, music, and narration.

What Is the Final Product? We will not attempt to tell the school's whole story. For example, comments such as "a school nurse comes in on Wednesdays and Thursdays to care for the students' health needs" will not be included. Rather each 5 to 7 minute video will be short, to-the-point, and punchy. The focus of each is the special, dashing, exciting elements of the magnet programs that make that school unique.

What we are creating is an "infomercial." Information is contained within what is virtually a commercial. Commercial are effective because they weave a mood, paint a picture, or create an impression instead of trying to tell everything about the product.

We plan to finish seven recruitment videos during 1993-1994. The remaining six videos will be produced the next year.

Interactive Kiosks

Kiosks are used in airports to dispense flight information, at zoos to share data about the animals, and at hotels to give guests access to restaurants, points-of-interest, and recreational activities. The kiosk is usually a small screen with touchscreen access contained inside a secure casing.

In the magnet schools we are tasked with getting correct, current information to the public—and in a way that attracts and keeps attention. We decided to create a kiosk that contains information about magnet schools, that is made spiffy through technology and multimedia, and that can be moved from site to site.

Content. We need the public to understand why magnet schools exist, what is available within the magnet schools, what it is like to go to a magnet school, and basic policies and procedures. Within the kiosk program, information is available about the philosophy of voluntary racial integration, the history of magnet schools in San Diego City Schools, bus transportation, eligibility requirements, waiting lists, categories of magnet programs, and information about the magnet schools.

How It Works. Our kiosk consists of a case which places the screen at eye level for an adult of average height, Quadra 700 Macintosh with *QuickTime*, a touchscreen, a 1.3 gigabyte hard drive, and an laserdisc player. The computer accesses the laserdisc for long bits of video or video that shows a lot of action and movement. For short video or "talking heads," we decided that the method for fastest access time was *QuickTime* movies.

Here's how it works. A person approaches the kiosk. A series of short attention-grabbing messages play across the screen in an endless loop until someone touches the screen. (We use our public service announcements, thus saving production time and making use of already existing "attention grabbers").

The person interrupts the PSAs by touching the screen. A menu screen offers the options. For example, let's say the person wants to hear about bus transportation and touches the bus button. The main menu disappears. In animation a yellow school zips onto the screen and stops. Buttons appear offering access to information about bus transportation being free to eligible students, bus routes, minimum number of riders necessary to start a new route, etc.

Three students are visible in the windows. When the viewer touches a window, the student's face changes from graphics to a *QuickTime* movie. The student gives a personal perspective about what it is like to ride a bus to school.

The viewer can interrupt any screen, return to the main menu, and choose to see and hear other information. We include a number of "testimonials" from students about their experiences in magnet schools to personalize the information.

Mobility. The kiosk will be housed close to the information booth in our district office to be useful to people who come in to ask about San Diego schools, but we must be able to move the kiosk to different sites. The kiosk will be used at parent meetings, community events, and with the general public. For example, when a school in a target neighborhood holds a PTA meeting, the parents will have access to information about their options in education. When the magnet program has a booth at a major community event at the convention center, we will use the kiosk to dispense information. The kiosk will be set up at shopping malls on days when a large number of parents and students are expected.

One of the disadvantages of the system is that the equipment is quite heavy, and it requires two people to move it. On the other hand, we hope the weight gives us some degree of security against theft. We secure the equipment within the case which is itself locked and equipped with a heavy chain that will "attach" the kiosk to something (such as a bike rack) when the kiosk is in a public location.

The Multimedia Production System

Computer Equipment. The basis of our multimedia system is a Macintosh FX with 160 MB hard drive. Because animation is very memory-greedy, we have an additional external hard drive plus a removable cartridge system. We also have a CD ROM, XapShot, black and white scanner, and color scanner.

Video Equipment. We purchased two SVHS/VHS Panasonic editing decks, a TV monitor, and two video cameras We round out our video equipment with a sound mixer and a portable sound recording booth.

Computer Cards. The signal that comes from a computer and the signal from video are not the same. Something must make the two compatible. Our link between the computer and the video equipment is a computer card, the TruVision NuVista+ card. With this card in the computer, we can "print" computer graphics and animation to video, and we can edit video, animation, text, graphics, action, music, and narration together using the computer as the edit control.

Software. I have used computer animation software called MacroMind *Director* most frequently. Another computer animation program from the same company is *Magic*. *Magic* has a somewhat shorter learning curve than *Director*. The software that ties the computer half with the video half of the system is MacroMind *MediaMaker*. We also use *Studio 32*, *MacroMind 3D*, *Swivel 3D*, *Accelerator*, and *PhotoShop*.

Graphics. I have often used the art program that is part of *Director* to create original art for animations. Our scanners work overtime to scan images. Also we have been known to use clip art for animations.

Music Capability. Music is a tricky area because most music is copyrighted. Yet having the proper music to undergird a production is extremely important. We solved this dilemma by buying a sell-out library of music on CD ROM that permits us to use the music for 99-years as long as we don't use it to make money.

We also bought the capability to produce original music. We have a MIDI system with software for music production through the computer, a keyboard, and equipment that expands the range of sounds from the keyboard.

This area is still undeveloped. We had hoped to have original music written by the advanced music composition class of a local community college. To date we still have not received original music. Fortunately we were able to get so many titles on the CDs that so far we have always found appropriate music themes for our productions.

What Problems Have We Had?

Naturally we have encountered challenges in multimedia production. The learning curve for the software has been one challenge. Some of the software can be eccentric. Any complicated technical system can break down, and ours has. However, the major problem has been lack of time.

When I first published an article about our use of multimedia in marketing, I optimistically projected that we might complete the modular video format the first year we had the system and that we would produce two new PSAs every two months (Kerney, 1992). The reality is that we will not finish the modular video formats until late spring 1993. And we have produced six PSAs instead of two per month. Since multimedia marketing is only part of our responsibilities, our production has been a little slower than hoped for.

What About Schools That Can't Afford an Expensive Multimedia System?

Our funding source has a dual commitment to improving academics and reducing racial isolation in the magnet schools. Funds were specifically targeted for permanent equipment to boost recruitment.

Obviously not every school has the finances to purchase an elaborate multimedia system. However, many schools already have elements to create a multimedia production studio. Many districts have video editing capability. The district probably has computers that are capable of supporting multimedia software.

To make the computer and video signals compatible, a special computer card is needed. Then, with the purchase of computer animation software, the school has created a basic multimedia system. Naturally, having all the other equipment and software that we mentioned earlier makes the system more effective and more flexible. But if a school already owns the computer and editing equipment, a few relatively inexpensive purchases can get a school started in multimedia for less than $4,000.

Then what are they going to do with it? Besides marketing applications and jazzing up video productions, multimedia is a natural for curriculum development and student projects. For example, last year in one of our magnet elementary schools, several sixth graders created an interactive lesson on the kelp beds. These 11-year-olds researched the kelp forests and the plants and animals that live there. They drew original pictures of the plants and animals which they scanned into a Macintosh in black and white. Next they used the art features in *Director* to colorize their drawings.

The students had received only a few hours training in *Director*. With this basic training, they animated their creatures and created an undersea world. This animated world was impressive, but the kids went one step further—into interactivity. When the viewer clicks on any plant or animal, the screen changes from the kelp bed to an informational piece including an illustration of the selected creature. Another click and the viewer is back in that shadowy watery world with the waving kelp, skittering starfish, dancing anemones, and swimming octopus.

The kelp bed lessons have been featured on television and at a large international multimedia developers conference. Unimpressed by their fame, students at the same school embraced the somewhat easier-to-learn *Magic* and proceeded to use both *Magic* and *Director* to create the animated human digestive system, illustrated works of poetry, and other exciting projects.

To Sum Up

In San Diego City Schools we have used multimedia extensively to market our magnet schools. We have public service announcements airing on television, and we produce new "commercials" to continue to flood the public with information about our fine programs. We have created "modular video" in response to our schools' desperate need to have up-to-the-moment recruitment videos. We have designed our prototype kiosk and will complete all aspects of the kiosk project over the next two years. In the future San Diego City Schools plans to continue school marketing using multimedia and promote the continued expansion of multimedia into curriculum.

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Acknowledgments

The San Diego City Schools magnet programs are fortunate to have received funding from the Federal Magnet Schools Assistance Grant for the past four years. Their commitment to magnet recruitment to reduce racial isolation has allowed us to purchase our multimedia equipment and make it work for magnet marketing in San Diego.

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How soon will teachers use virtual reality in the classroom?: A discussion of the proposed use of virtual reality in San Diego Magnet Schools

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What Is Virtual Reality?

Virtual reality is the special interaction between human and computer which allows the person to have the sensation of being *inside* and actively engaged in the three dimensional computer "world." To become fully immersed into virtual reality, the person wears a "head-mounted display helmet," goggles, or special glasses and navigates through the computerized image with a computerized glove, "wand," joystick or 3D mouse.

Thus equipped, the virtual world traveller can view the artificial "world" of the computer from the inside. The 3D graphics world appears to be above, beneath, and all around, hence a sense of being fully immersed and being able to move or "fly" all around the virtual environment.

Virtual reality as described above is a recent technological phenomenon although it had beginnings in research and experimentation by academics and military designers as early as the 1960s. The current term, "virtual reality," was coined in the 1980s. VR quickly engaged the public imagination, and hardly a week passes without some mention of virtual reality in the press or on television.

Who Cares?

Many experts are of the opinion that entertainment will drive VR's development. Wildly popular entertainment uses VR such as Battletech in Chicago, Fighter Town in Irvine CA, and Virtuality's "Dactyl Nightmare" gamecenters around the world. Home entertainment companies such as Nintendo and Sega are threatening to place virtual reality in the home by 1993.

Other fields of endeavor that use virtual reality now or that have plans to develop virtual reality soon are medicine, finance, data management, training, and architecture. VR is used in the remodeling of kitchens in Japan and the design of the Berlin subway system.

Physicians are interested in VR applications. Several hundred doctors and people affiliated with the medical community recently attended a "Medicine Meets Virtual Reality" conference to investigate VR medical solutions. Virtual reality is truly just "meeting" medicine at present; most practical applications still lie in the future. But with teleoperations, medical training, practice surgery, aid to the disabled, and psychological therapy becoming realistic possibilities, the medical field seems to be taking virtual reality seriously.

What About VR in Education?

If you happen to attend a virtual reality conference, at least one speaker is certain to name education as a potentially huge field for VR applications. But if you ask who is using VR at present, you discover that few school districts or educational institutions have taken advantage of this technology—yet.

To date virtual reality has been used at several pioneering educational centers. West Denton High, in an impoverished area in England, has introduced the design of a virtual city where different languages are spoken to teach foreign languages. The Pacific Science Centers in conjunction with the Human Interface Technology Lab of the University of Washington ran VR summer camps during 1991 and 1992. During these weeklong camps, students in fifth through eight grades learned computer skills, planned their projects (called "worlds" in VR vernacular), designed 3D objects to people those worlds, and put on the VR gear to "fly" through the worlds they created.

Our office has recently joined in a partnership with the San Diego Supercomputer Center to develop similar virtual reality summer institutes at the UCSD campus during the summers of 1993, 1994, and 1995. The Supercomputer Center is seeking special funding. If funded, 60 students plus six teachers from math/science/computer magnet schools will experience weeklong camps in virtual reality at the Supercomputer Center.

At a recent conference attended by this author, experts in virtual reality from such organizations as AT&T, SRI, and NASA were asked, "What is keeping virtual reality out of education?" Their answers included:

- Virtual reality is too expensive for schools.
- The technical quality of VR is not quite good enough.
- The imagination may be lacking in education to make it happen.

Our school district has plans to overcome these challenges and use VR with students at the elementary, middle, and high school levels.

What About the Challenges?

Is a marriage between virtual reality and education realistic? To become widespread in education, virtual reality must answer instructional needs, motivate students, have technical quality, find educators with imagination, and fall within a school's budget.

Instructional Needs

Because of the nature of virtual reality, education can reap huge benefits from using VR with students. Educators are always seeking solutions that allow students to see and hear lessons but also to "experience" learning. In addition, teachers have always believed that students learn by doing—and by teaching what they know to others.

Virtual reality meets instructional needs by:

- increasing cooperative learning opportunities and planning abilities by bringing together small groups of students to design and build a "virtual world" including its instructional objectives and content;
- spurring imagination and creativity by allowing students to design and create the 3D images which will populate the virtual worlds using three-dimensional modeling computer programs;
- allowing for success for students who may not succeed at the usual instructional tasks of reading and writing or whose English skills may be inadequate by providing an alternative learning method in 3D modeling and construction of objects in the computer world;
- improving computer skills;
- motivating students to want to participate in the learning experience;
- engaging the students through various learning styles while inside the virtual world by allowing the learner to see, to hear, to "touch" objects, and to move objects—in short to interact with computer-generated objects and people;
- allowing the learner to experience situations that may be impossible or distant or dangerous in the real world but which can be created and then interacted with in the virtual world.

Student Motivation

Most students enjoy designing original art projects. Three-dimensional art adds depth and complexity that appeal to youthful designers. In addition, using computer art programs provides a new artistic medium.

Virtual reality is interactive. Once in the VR world, the student interacts directly with objects and images. Many educators will cite interactivity as an important motivating factor for students.

Research suggests that students are highly motivated by creating and using virtual reality. Reports from the Human Interface Technology Lab in Seattle indicates that kids using virtual reality would rather "go into a virtual world" than play a video game, use their favorite computer program, or watch TV—*by an overwhelming margin* (Bricken & Byrne, 1992).

Technical Quality

The criticism that quality is low in virtual reality is valid. It is said that, when in the virtual environment, a person is "legally blind." However, technical experts in the field say that the quality will improve rapidly. The equipment that San Diego City Schools proposes to purchase is of sufficiently high quality that the level of vision is not distracting to the person in the virtual world.

Imagination

Excitement is rippling through the three schools where virtual reality is proposed. Teachers have already started planning imaginative projects to entice and stimulate their students. With the teachers who have committed themselves to this project, neither imagination or enthusiasm is a problem. The school's ideas for projects will be discussed later.

Budget

Virtual reality costs are plummeting as the technology becomes more widespread. Until recently the cost was much too expensive for schools. A high end VR system could cost hundreds of thousands of dollars. Now a complete virtual reality development and run-time system costs less than $15,000.

The initial design and development of virtual reality can be created with 3D software on PCs or Macs. A school needs only one complete VR system (computer, special virtual reality software, a "head-mounted display," a tracking system to link the head-mounted display to the computer, and a navigational tool) to allow students to "enter" the VR "world."

Virtual Reality in San Diego Magnet Schools

In San Diego City Schools' magnet programs, we plan to introduce virtual reality as a learning tool during 1993-94 into three magnet schools each of which already has a technology focus:

- Chollas Math Science Magnet (K-6),
- Keiller Academy for Science and Technology (6-8), and
- Lincoln Preparatory High School for Medical Careers, Humanities, and Foreign Languages (9-12).

Virtual Reality in an Elementary School

Chollas is an elementary magnet school that focuses on math and science and has a strong technology component which support those subjects. The proposal is to integrate virtual reality into the math and science curriculum.

Chollas students will design their virtual environments in the already existing Macintosh computer lab. The VR system will be used to convert the graphics, assign "characteristics" (colors, color changes, gravity, no gravity, movement, etc.) to the objects, and allow students to "enter" the worlds they have made. The VR system is portable and can be housed in the lab or moved from room to room on a rotation basis.

The following are among several proposed virtual reality projects:

- Older students create a virtual world focusing on colors and shapes. Younger children use the world to reinforce learning.
- Science students identify molecules in the virtual world and create new molecules by moving atoms around.
- Students create and visit a virtual solar system with planets correct in appearance, relative size, and distance from the sun.
- Math students manipulate math concepts from inside the virtual world.
- Science students visit the digestive track (from the inside).
- Chollas' young scientists design a gravity-less world.
- Students meet and interview the (virtual) people who have molded present day math and science.

Virtual Reality in a Middle School

At Keiller Academy of Science and Technology two teachers propose to introduce virtual reality, one a sixth grade core/social studies teacher, the other a seventh and eight grade science teacher. The two virtual reality systems will be housed in their rooms although they may be moved to other classes for demonstrations or instruction.

Keiller has introduced the following among other ideas as virtual reality projects:

- Science students develop a virtual room with science apparatus and safety equipment. Students demonstrate their recognition of science equipment and their knowledge of safety rules.
- Science students develop a room with simple machines on which students place weights on a lever to demonstrate how the mass and distance from the fulcrum affect the operation of the lever. Many other machine concepts can be designed into the virtual room.
- Since middle school students are often gamemasters, students design interactive virtual reality games which teach science concepts.
- Sixth-graders will use virtual reality in social studies. Imagine students applying their knowledge of the ancient world by creating an Egyptian city where they can enter, "walk" through, and discourse with ancient Egyptians!
- The school will provide an after school special interest club to expand virtual reality to those who are highly motivated and provide extra time for students who are especially motivated by the technology.

Virtual Reality in a High School

Lincoln Preparatory High School is a health professions, humanities, and foreign languages magnet. Lincoln plans to hire a special curriculum writer/project manager to plan and oversee the virtual reality projects. Virtual reality will be used in student projects in medical profession classes during 1993-1994. The following year virtual reality will expand into English classes to allow all students to experience virtual reality.

Lincoln will integrate virtual reality into its magnet with student projects such as:

- Medical students can work with medical emergencies in a virtual hospital.

Implementation and Commitment

The heavy demands of teaching can distract even the best-intentioned teacher. To ensure that the virtual reality projects keep on track, we plan for a central resource teacher to coordinate the virtual reality projects at the schools. Teachers from each of the schools will be trained on the 3D modeling software and the virtual reality system. Teachers integrating virtual reality into their classrooms will have paid curriculum development time to plan and design.

What Could Go Wrong?

Implementing virtual reality into the schools as proposed here is dependent upon renewed grant funding. Our office has been funded through the Federal Magnet Schools Assistance Grant for the past four years. We are including the introduction of VR as part of our proposal for the 1993-1995 grant.

If our grant is not funded, implementation of virtual reality will probably not come to a screeching halt because excitement is too high in the schools. However, the virtual reality project is not likely to be as extensive as described here.

To Sum Up

In San Diego City Schools magnet programs we propose to link critical thinking, creativity, and technology through student projects using virtual reality. Students apply problem solving when they plan the instruction and use visual/artistic skills when they create three-dimensional graphics. Virtual reality is an open invitation for students to explore their own creativity and unlock their imaginations through cutting edge technology.

Perhaps San Diego may be adventuresome by introducing virtual reality as a learning tool, but signs indicate that virtual reality may become as common in the future as desktop computers are today. In our magnet schools, we want to get our students ready for the future, and we are committed to using technology and teaching tools that prepare our students in the most effective way we can imagine. Virtual reality may prove to be just such a tool.

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The interactive VCR: An alternative approach to developing interactive multimedia

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Introduction

Most educators agree that instructional programs which facilitate the learning process share common qualities. These qualities include; (a) instruction which is relevant to the learner's needs, (b) an instructional format which is appropriate to the learner's learning style and, (c) instruction which encourages active—rather than passive—learning.

The development of interactive multimedia programs over the past ten years has demonstrated the potential of interactive technologies in meeting these needs. Video disc, compact disc read-only-memory (CD-ROM), and computer driven instruction are three of the most common forms currently available. Unfortunately, these programs are still few in number, and are not always compatible with established curriculum needs. Teachers must often resort to writing their curricula around existing multimedia programs.

Because of these detriments, many school districts have hesitated to invest money in technologies which currently have limited promise in meeting the needs of their teachers and students. Fortunately, an alternative is now available which allows curriculum directors, teachers, and even students to easily assemble interactive multimedia presentations without the common limitations often associated with site-developed multimedia programs. This alternative is the interactive videotape, driven by an authoring program such as HyperCard™.

Interactive Multimedia Revisited

Ambron and Hooper describe interactive multimedia as "a collection of computer-centered technologies that give a user the capability to access and manipulate text, sounds, and images" (1990, p. xi). In recent years, the potential of interactive multimedia has generated excitement within the educational arena because of the advantages of this media over the more traditional, linear formats. Being interactive, the media demands that the user participate not as a passive viewer, but an active participant. By making choices which direct ensuing instruction, the user engages in a variety of higher level thinking skills based on the analysis, synthesis, or evaluation of previously presented material. In addition, because it is the learner who is choosing the path through the instruction, the locus-of-control is shifted away from the designer and back to the user (Florin, 1990). This permits the user to "discover" the knowledge, which in turn, makes the knowledge more meaningful and memorable.

Because the material is presented in a multimedia format, it often offers the user multiple representations of the same information. Whereas some students may understand the material as initially presented, other students will learn more effectively or efficiently if the material is presented in alternate formats. Howard Gardner describes this variation in learning formats as multiple intelligences (1983). He has described seven separate types of personal intelligence: logical-mathematical, linguistic, bodily-kinesthetic, musical, spatial, interpersonal, and intrapersonal. Although autonomous, these learning modalities can combine to allow deeper meaning and learning to take place. An advantage of interactive multimedia is that the user can not only favor his or her preferred learning style, but by presenting the material in multiple modalities, the various "intelligences" are stimulated and help deepen the learning. According to Jenkins, this multifaceted approach helps: (a) extend the sensory content (providing information through music, video, animation, etc); (b) provide multiple learning contexts (compressing hours into seconds, or changing visual perspective); and (c) offer a safe environment for "risk taking, experimentation, exploration, and problem solving." (1990, p. 117).

Although interactive multimedia has far reaching applications, there are dangers inherent with this format. Most noticeable is the increase in cognitive load as the user navigates through the material (Oren, 1990). Knowing where one has been, where one presently is, and where one is going is a constant problem as users move away from the main menu. A second problem is that developers and users often assume that if they are working with interactive multimedia, they will automatically be accelerating their learning. However, interactive multimedia doesn't guarantee success any better than having a dictionary guarantees the proper spelling of words.

Interactive Formats

Currently, there are three major formats in which interactive multimedia projects are being developed (see Table 1). These formats vary in their storage form (magnetic or optical), signal type (digital or analog), developmental location (factory or in-house), storage capacity (80 mb to 1,200 mb), and idiosyncratic advantages and disadvantages. Because of these variables, an all-purpose format has yet to emerge.

The computer is the most well-known form of interactive instruction. The high access speed of today's computers allow sound, graphics, and text to be presented to the user almost immediately upon request. Instructional software can be created and modified by the teacher to meet specific instructional needs. The software can then be duplicated for use by several users at a time with no loss of data between duplications. The relatively small storage capacity of the magnetic format, however, limits the computer to relatively short segments of sound or video encoded into the disc. Because video and sound are often critical components of interactive multimedia, the lack of space to store large files constrains the use of computers as stand-alone sources for multimedia. As larger storage capacities and better data compression become more commonplace, this constraint will diminish over time.

Because of its increased storage potential, optical data

Table 1
Attributes of Multimedia Formats

Type	Medium	Storage Capacity	Advantages	Limitations
Computer	Magnetic	80 mb is common	Fast access Digital signal Customizable	Limited storage Minimal video capabilities
CD-ROM	Optical	650 mb	Fast access Digital signal	Low availability Read only Must purchase
Videodisc	Optical	~1,200 mb 54,000 frames 1 hr. video/side	Fast access Freeze frame Digital signal	Low availability Read only Must purchase
Interactive	Magnetic	7,000 mb 6 hours video	Customizable Abundant resources Low cost	Slow access Analog signal

systems are increasingly being used for multimedia applications. With its compact design, CD-ROM may well develop into the multimedia choice in the future. Today, however, available instructional products in CD-ROM format are rare, and teachers are often left to design instruction around the CD-ROM program rather than integrating the program into the instruction. The slow acceptance of this format has occurred because they are somewhat limited in their ability to store full-motion video, and access time is currently much slower than a typical computer hard drive.

The videodisc is a format similar to the CD-ROM, but designed more for the storage of video and sound data. Its larger size allows it to hold up to an hour of full-motion video with accompanying audio on each side. Other advantages include its quick access time to any frame, and its ability to freeze on a single frame without causing any damage to the disc or player. Like the CD-ROM, the videodisc is currently a write-only medium, meaning it cannot be altered after purchase.

Which medium is best? Because each media has its own advantages and disadvantages, there is no clear-cut answer to this question. The choice revolves around the available equipment, available software, instructional objectives, and on whether the teacher is planning to purchase or develop the multimedia presentation. Most advantageous would be a medium which has the best characteristics of the video disc, CD-ROM, and computer. Although such a medium does not yet exist, a fourth choice is now available. It fills a specific niche because it; (a) allows the teacher to create a unique multimedia product specific to his or her needs, (b) allows the learner to access a great deal of audio and video information, and (c) is inexpensive. This medium is the interactive videotape.

The Interactive VCR

Description

The serially controlled video-cassette recorder (VCR) is a recent development in interactive video technology. The VCR is equipped with a microprocessor and serial port which allow commands to be sent to the VCR via a computer. The microprocessor reads the codes and directs the VCR to perform the corresponding function such as play, stop, or rewind. The VCR can also perform normal functions using the controls on the VCR face plate.

Advantages

The price of creating a multimedia product on most conventional media is considerable. The cost for pressing a single videodisc from a 1" master videotape is approximately $300. The cost of creating a CD-ROM is similarly high. In addition to the initial cost, because a videodisc and CD-ROM can only be written to once (read only media), these materials cannot be revised or updated.

The interactive VCR provides the teacher with the power to design and develop his or her own interactive lessons from start to finish at the cost of a single videotape. No longer limited to instructional content offered on videodisc or CD-ROM, the developer can tape material with a camcorder and use the videotape as the source material. With the addition of an authoring system such as HyperCard™, inexpensive interactive multimedia products can be created. Students with adequate experience with a camcorder and authoring system also have the opportunity to create their own interactive products. In addition to newly taped material, video from television, movies, documentaries, news clips, and other archive sources can be readily used as a stand alone video source or integrated piece-by-piece into a custom-made tape.

The task of finding relevant existing video materials to match instructional objectives is much easier in the videotape format than with videodisc or CD-ROMs. Not only are videotape materials more plentiful, but they are significantly less expensive. In addition, because they are more available, more widely used, and offer greater diversity, administrators are more likely to fund videotape expenditures in the belief that because the materials can be used by a larger number of faculty, they are more cost-effective.

In addition to its use as an instructional product for the individual learner, the interactive VCR can serve as a useful tool for video indexing. A video index made of resource tapes, complete with names and time counts of useful video segments, allows for easy access to appropriate materials. This procedure would circumvent the time-consuming procedure of fast forwarding and rewinding to locate a desired segment, and allow the teacher to be free to focus attention on the day's lesson while the VCR locates the segment. This application of the VCR also adds a new dimension to activities involving the VCR: the teacher has the power to replay certain segments, skip unwanted video portions, and perform other functions which both remove irrelevant materials while providing time for student interactions.

Limitations

Despite the flexibility which the interactive VCR enjoys over the videodisc player, it is still bound by the limitations inherent within the medium. The most noticeable is the longer access time needed to locate a segment. Whereas most videodisc segment can be accessed within two seconds, a needed segment on the opposite end of a 30-minute videotape will require a full minute to be located by the VCR at full speed.

A second limitation of the interactive VCR is its inability to maintain a still video image. When compared to a videodisc, most VCRs not only lack the ability to display a clear still frame, but a long pause puts excessive wear on the tape, resulting in tape stretch, dropout, and dirtying of the VCR playback heads. Many VCRs automatically stop when the machine is held on pause for too long a period of time.

Most low-end commercial-grade VCRs do not use time code to determine the location of a tape in the VCR. Many use a much less expensive method: they gauge the speed of the rollers which transport the tape and approximate the amount of tape which has passed through the rollers. The inaccuracy of this method is not great, but will become significant if the tape needs to be accurate to a fraction of a second. Further inaccuracy is caused when the tape is repeatedly fast forwarded and rewound.

Interactive VCR Strategies

To minimize the limitations of the VCR, teachers can employ a variety of strategies when using or developing videotapes for use in interactive lessons. These strategies include:

1) Calibrate the VCR periodically during the lesson. This can be done by rewinding the tape to the beginning and resetting the VCR counter to zero. Because this action takes time to perform, it should be used sparingly. Fortunately, some players can initiate this action from script commands sent by the computer.
2) Keep the most often used video segments near the beginning of the tape. Placing segments near the beginning of the tape will allow you to periodically calibrate the VCR while accessing them with a minimal loss of time.
3) Place segments adjacent to one another which will probably follow each other during the lesson. This will minimize access time between most segments.
4) Use the computer screen to provide information while the VCR is cueing to a segment. This will maintain the learner's attention on the instructional material while the VCR is cueing to the next segment.
5) Allow about two seconds of dead time between video segments when producing your own instructional video material. This will prevent overlapping of segments caused by inaccuracy in the VCR counter mechanism.

Using HyperCard™ with the AG-1960/RS

The Instructional Media Lab (IML) at San Diego State University uses the AG-1960/RS, a Panasonic VCR which has been converted to serial control by Selectra Corporation. The conversion allows the player to be controlled by either a Macintosh or DOS computer. Selectra does not convert existing machines as an aftermarket service, but instead sells the complete VCR unit and controlling software for $1,865.

The AG-1960/RS was purchased by the IML to be controlled with a Macintosh computer. The purchased package included the player, a software application for controlling the VCR through a palette with VCR-like icons, and a HyperCard™ stack which included resources for controlling the VCR. When these HyperCard™ resources are installed into other HyperCard™ stacks, commands can be placed into object scripts which perform VCR functions at specified times.

Unlike Level III videodisc systems, the VCR drivers for the AG-1960/RS do not require the installation of special files into the System Folder of the Macintosh. This convenient feature allows the VCR to be controlled through any Macintosh without special preparation.

Because the HyperCard™ stack included with the VCR was not well suited to the needs of the IML, a developer's stack was created on site which included a resource copier, built-in video palette, and simplified script commands for controlling the VCR.

All normal VCR functions can be performed through the computer, including tape transport, counter reset, power on and off, and eject. The VCR can also be commanded to cue to a specific counter location, play a segment, play from a frame, or play to a frame.

The VCR can also be used as a simple video editor. It performs independent audio and video insert editing from and to selected counter locations. Its capabilities are limited in this domain, however, because only one VCR can be controlled through the computer: the source VCR would need to be controlled manually.

The Selectra VCR has a unique command which rewinds the tape currently in the VCR to the beginning, then resets the counter to zero. This calibrate command corrects any inaccuracies in the location of the tape within the VCR caused by slippage through the tape transport mechanism.

A problem encountered with the microprocessor of the AG-1960/RS was an occasionally freeze up, preventing the VCR from operating through the computer. When this occurs, the user is required to unplug the VCR for a few seconds, then plug it back in. This clears all commands from the microprocessor, allowing the VCR to again perform normally. Outside of this occasional inconvenience, the machine has been very responsive.

Conclusion

Teachers today face the dilemma of preparing students for a technological world with a scarcity of resources. They must find materials which fit their curriculum and yet are inexpensive. The interactive VCR offers a promising solution. This product provides a unique way of allowing teachers to create original interactive multimedia products for the classroom with more flexibility than the computer alone, yet at the fraction of the cost of higher-end optical media.

For information regarding the AG-1960/RS, contact:
Selectra Corporation
P.O. Box 5497
Walnut Creek, CA 94596
(800) 874-9889

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Video-based tutorial and drill for a classical dance form

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Introduction

Advances in computer technology have paved the way for the easy incorporation of video in computer based educational systems. The use of video in CAI has spawned a new field called computer assisted video instruction (CAVI). The effects of video incorporation in instructional material has been the subject of extensive research. The Interactive Video Project at the Bank Street College [Char, Newman, & Tally, 1987], the effects of computer animation on adult learning [Riber, Boyce, & Assad, 1990], effect of graphic feedback on student learning [Surber & Leeder, 1988], the effects of interactive video enhanced instruction on the achievements of seventh graders [Levin, 1991], offer insights into the relative merits and thought provoking questions on the wisdom of using video in CAI. While much debate and research is going on evaluating the effects, wisdom and merits of video incorporation to enhance traditional character based CAI, the area of developing video-based CAI for topics that can only be taught with video has largely been ignored by the research community. Tennis and ballet are good examples of topics that can only be taught using animated sequences of images.

While it is very easy to see the merits of video incorporation in the CAI of dynamic topics like dance and sports, the question remains of the effectiveness of these CAI material. Students may be shown sequences of graceful dance or powerful tennis strokes. The crucial question then is how can the CAI evaluate student progress and offer feedback? CAI presents information to students in the form of images. A particular tennis stroke or a dance body posture is presented in an image form and is often supplemented with text. How can the student convey back to the computer what he/she has just learned? CAI can use the traditional multiple choice format: display four different images and ask the student to pick the right one. A drawback with this approach is that the student may know what exactly to do, but may not do it the correct way. Assume for a moment that CAI system were able to see the student in a particular body posture, compare this with the correct body posture and offer feedback. This kind of feedback could help the student correct mistakes and make learning very effective.

In this paper, we describe in detail the issues we encountered while attempting to design a CAI system for the instruction of Bharathanatyam, a classical Asian Indian dance form. The problems, their solutions and the limitations of the present technology can be considered representative of those faced by CAI systems for topics involving dynamic change. A detailed analysis of the strengths and weaknesses of such a closed loop CAI system is also given. The results of this project extend the concepts of traditional text based CAI Tutorial and Drill systems to video based CAI.

Video-based tutorial

The basic steps of a dance form or a sport can be presented in the form of video tutorial. The first step is to identify the basic steps or building blocks to be presented. In a character based system, only a single layer of information is presented at a time. In a video tutorial, in which images are presented in an animated sequence, several frames are shown per second to create the perception of motion. A video tutorial should at least provide for easy navigation among frames in a single sequence. Suppose, a minute of video is presented at ten frames per second, the user should be able to access any one of the six hundred frames. Otherwise, there is potential for information loss. Whenever required, the tutorial should provide multiple views of the same item. Side, top or bottom views, close up of critical parts of the body movement, etc. should be available for review by the student.

Video Drill

In the area of sports and dance forms, drills are very important. Body postures, weight transfer and timing, etc., are acquired through repeated practice. A CAI-based Drill can greatly aid the student in identifying how close he/she is to the desired body posture or timing. The expert (or ideal) image is the correct answer. The student is videotaped in a particular posture. This video clip could consist of a basic dance step or in the case of tennis, the execution of a forehand drive. Upon displaying both the expert and student images, the CAI system should prompt the student to compare and contrast the important features. While the CAI system is authored, an expert in the field should be consulted to identify errors often committed in a particular topic and these factors should be included in the prompt.

Prototype Demonstration

The requirements for video-based tutorial and drill enumerated in the previous sections, are illustrated in a computer-aided instructional system for Bharathanatyam, an Asian Indian dance form. The first author has been involved in teaching and performing this dance form for the past fifteen years and the CAI material has been developed based on her personal experience. Video images were collected from several sources including documentaries produced by the Indian Television. This project was developed using HyperCard and QuickTime.

Introductory features on the practical as well as theoretical aspects of the dance form have been included in this video-based CAI system. This is particularly important because the theoretical aspects are often overlooked in a dance class. This sometimes has serious repercussions because the students are unable to develop their talents beyond a certain level. The interested and committed students learn the theoretical aspects on their own from books. But most of the dance terms are sanskrit based and the student may not always know how to pronounce new sanskrit terms. In a computer based approach, the students can learn the theoretical aspects on their own. The auditory portion of multimedia enables one to learn the correct pronunciation. The goal was to study the advantages and disadvantages of teaching dance with the aid of a computer.

The program is composed of several stacks, each of which describes an aspect of Bharathanatyam. The first and second stacks give a brief introduction to Bharathanatyam. They explain the salient features, history and origin and the basic aspects. The third stack describes in some detail the various gestures involved in Bharatanatyam. These include hand and foot gestures, eye movements, etc. All the gestures are explained with their meanings and pronunciations. Video images have been used to demonstrate the various gestures. Buttons to teach the pronunciation of names of gestures have also been included. The right way to place the hands or the correct body posture or the precise way to do a step cannot be learned from a book. The different uses of each gesture along with a video animation has also been included. This not only helps users learn these gestures, but also encourages them to indulge in elementary choreography. This will instill more confidence in them and provide a more motivating learning environment. The fourth stack covers another aspect of the dance, expressions. The content of these stacks was chosen based on the author's extensive experience first as a student and then as a teacher. The basic stacks were also tested on a selected group of Asian Indians with some knowledge about the dance form. Appropriate modifications were made to the basic stacks based on this preliminary testing.

The user has easy access to help menus at all times which makes using the program simple. The user can quit the program anytime and return to the program whenever they want to. The users can learn the dance at their own pace. Unlike a teacher who is not available at all required times, this program is. Also the detailed indexing enables the users to access whichever part of the program they want to look at.

At the end of each stack, short quizzes have been incorporated to familiarize and reinforce what the users have learned in that particular stack. If they answer incorrectly, they are given corrective feedback. Most of the questions are of a multiple choice nature. For example they may have been given the meaning of a particular word. They have to pick the right word from the choices given. If the users choose the wrong word, then they are given the meaning of the word they chose and then given another chance to choose the right word.

and compare them frame by frame. The card shown in Figure 3 is the general frame work for the comparison of expert and student movies.

The expert movie is the same as the one presented in the tutorial. Initially the student learns a basic step using this image, then the student is videotaped while practicing this step. This movie is digitized into the computer for comparison and evaluation. The steps to be video taped will be presented at the end of each lesson. At the end of the lesson, the student is given a list of steps he/she should videotape and bring back to the CAI system. Text-based prompts are presented to aid the student in comparing his/her progress. This is shown in Figure 4. It can be seen that the student's elbows are not kept away from the body, and the text-based prompt makes sure that this point is not missed. The video-based drill provides an environment for the comparison of the two images as well as the factors that should be used in the comparison. A different form of prompting was also implemented. This made use of the sound capabilities of the Hypermedia. In the expert images, sound was incorporated to point out the most commonly made mistakes. When the expert movie is played, the voice prompts the students to compare certain features.

Technical Details

The images used in this project were taped using a regular VHS camera. Images were captured at ten frames per second. Most Macintosh models can play back digitized video at ten frames per second. Several compression ratios were experimented with. Most of the movies were compressed at either 2.5 or 3.25 (on a scale of 4, with 4 being the original uncompressed image and 1 being the most compressed). The longest movie was about a minute. While an analysis of the different compression settings was attempted, it did not lead to any interesting conclusions. The file size depends on the complexity of the dance step. If there is a lot of motion in a particular movie, the compression was not very effective. Each minute of video required approximately 6 megabytes of storage.

While the design of the HyperCard-based stacks requires careful consideration, the designing of the video sequences is also equally important. The lighting, combination of colors, the angle of view and the composition of the frame are factors requiring careful consideration. There is a slight change in color when an object/person is taped using the VHS format. There is also a color shift going from VHS format to captured (digitized) video. A light or white background looks good both on VHS and in digitized form. Video editors can be used to create background effects. When different views of a single dance step were taped, each view required a separate lighting arrangement. For example, taping of the whole body movement and just the foot work of the same dance step required drastically different lighting arrangements. In the first case, the entire body is illuminated while the later requires concentrated light only on the feet. Very bright light focussed on the feet produced poor images. The best way to get a feel for this was to keep a

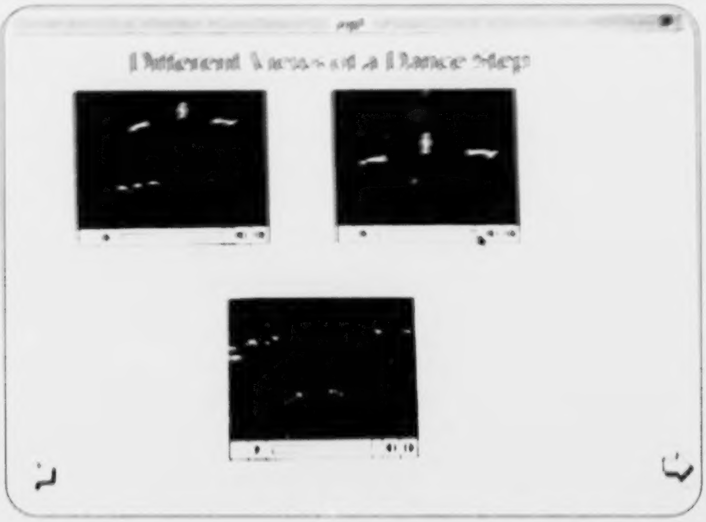

Figure 2. Simultaneous presentation of the three views pertaining to a single dance step. The controller at the bottom of the movie window provides frame by frame access to the movies. The number of different views presented varies with the complexity of the dance step.

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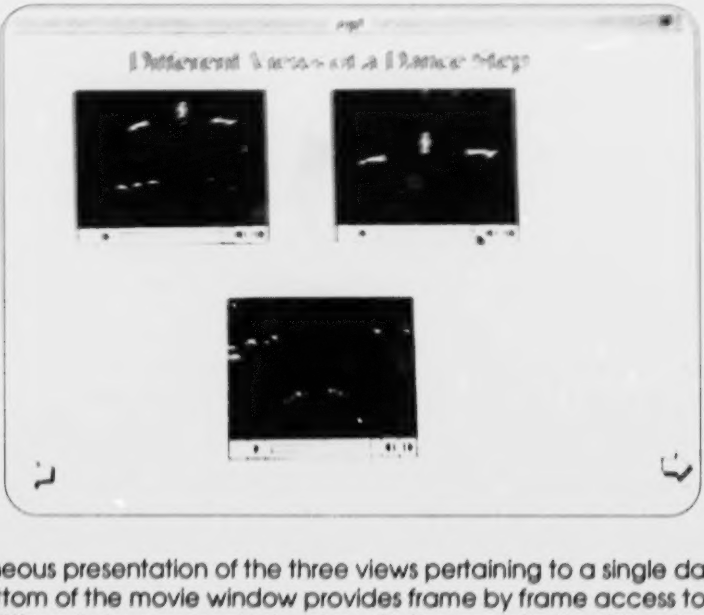


Figure 2. Simultaneous presentation of the three views pertaining to a single dance step. The controller at the bottom of the movie window provides frame by frame access to the movies. The number of different views presented varies with the complexity of the dance step.

careful record of all the light positions during the initial taping, experiment with different combinations, and then capture these images and decide on the best one. Care was taken to avoid taping the shadow of the person being taped, since the shadows do not look good in captured images and severely degrade the quality of the captured image.

Video Spigot allows one to capture sound simultaneously during video capture using the MacRecorder. During the videotaping period, in general it was difficult to work on the video and audio at the same time. Several attempts were required to make a single video recording. Incorporation of sound into these movies added to the complexity. Since video editors allow for easy incorporation of sound at a later time, it may be better to separate the sound and video recording as well as capture. In situations where the movie was captured from a performance tape or a TV documentary, capturing sound and video at the same time did not prove to be a problem.

Strengths of video-based CAI

Images are a logical extension of text. In one sense an image can be thought of as simultaneous (parallel) presentation of many characters. The technology permits the inclusion of image based student responses, which greatly enhances the capabilities and applicability of CAI.

The video presentation has been designed to incorporate the teaching strategies followed by an instructor in a class. For example, when teaching a hand movement, the instructor will show that movement part by part, clearly specifying where and how each hand is placed at each part. However, due to time constraints and the number of students in the class, the instructor will not be able to demonstrate a movement in detail more than two times. In complex steps, the student may forget what was taught in class. In such situations, the video-based tutorial offers enormous help. The video-based CAI also frees the instructor from having to repeatedly demonstrate the same step and instead use the time for more creative topics.

- The instructional video can be watched frame by frame. Thus critical timing errors can be easily understood and eliminated.
- The drill part offers valuable feedback. The student can progress at his/her own speed and does not have to wait for an instructor to analyze his/her progress.
- The quality of feedback is also greatly improved because experts in each field can be consulted during the initial stages of the design. Students who do not have physical access to these experts can still utilize the experience of these experts through CAI.

Economics

Video-based instructional tools have been used for many years. Professional sports teams and premier dance companies have used them extensively. The introduction of VCRs in the late 1970s has resulted in a wide selection of instructional videos for the individual household. These videos do not offer feedback. In order to compare and analyze, at least two TV monitors and VCRs are needed. For the price of an extra VCR/TV combination, an

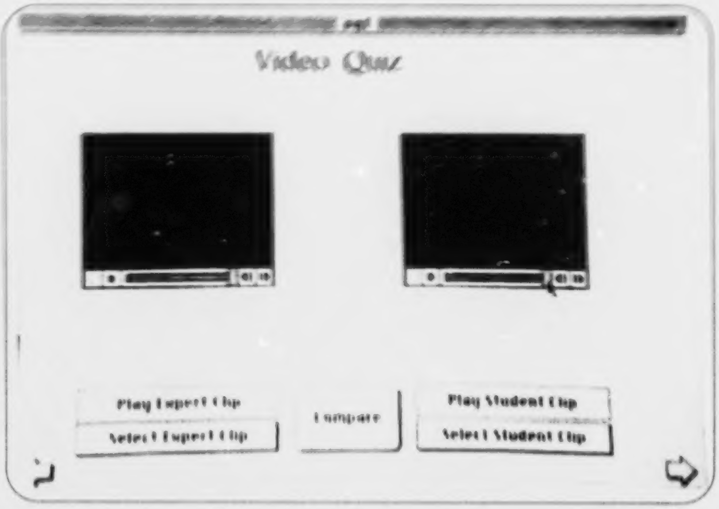
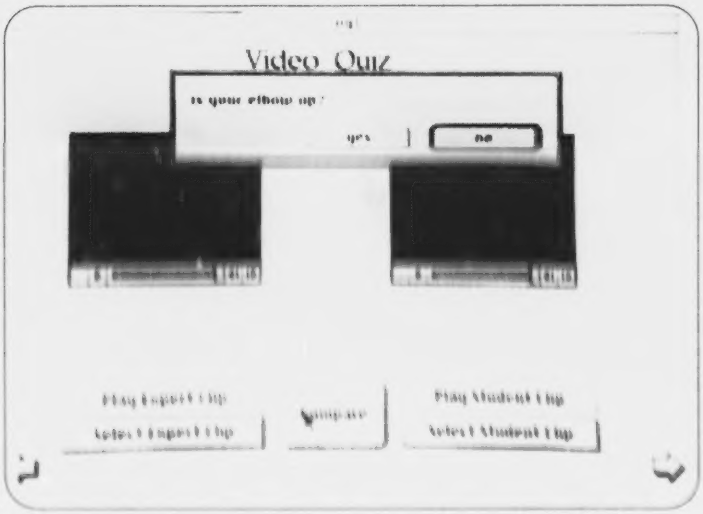


Figure 3. The general framework for video drill. The buttons are used to select and play expert/student movies. The controllers are provided to aid frame by frame comparison of the two movies. Because of these controllers, sophisticated time coding of the movies is not required to coordinate the two sequences.



Is your elbow up?

Figure 4. Prompts for comparison. The button named compare activates the prompt dialog boxes for comparison. It is easily seen that the student (on the right) is not holding the elbow correctly. This is pointed out in the character based prompts. Voice based prompts have also been included in some cases.

existing personal computer can be easily upgraded with extra memory and a video capture card. For less than a thousand dollars, an existing computer can be upgraded to handle all of the above mentioned features of video tutorial and drill. Almost all sports clinics offer videotaped analysis. A computer assisted analysis will greatly enhance the quality of the feedback offered. With CAI, the student can spend as much time as he/she needs and can go through the analysis at his/her own pace.

Conclusion

A video-based CAI system for Bharathanatyam, an Indian dance form, has been described. Many of the issues faced during the design of such a system can be considered as representative of problems associated with the design of video-based CAI for any topics dealing with dynamic change. The preliminary implementation has clearly demonstrated that image-based CAI is a very effective teaching tool in the fields of dance and sports. The technology is in the early stages of development and given the characteristic rapid progress in the computer field, image-based student responses in CAI should become very economical to use in a few years. Rather than waiting for such a time, we can start to work on prototypes and transfer the knowledge gained from such prototypes to widely-used products in the future.

The concepts of video-based tutorial and drills have been described and their characteristics briefly discussed. The attributes of video tutorial and drill covered in this paper can be used as general guidelines in the development of other video-based instructional material and thus aid teachers involved in the production of video based instructional material.

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The Magic Wall: Integrating computers in multiscreen teaching

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In 1967 at the Montreal World's Fair, General Motors, IBM, AT&T and a number of nations competed in multiscreen presentations to impress international audiences. Varying from three screen interactive experiences to diorama spectaculars, the presentations were dazzling and at times allowed the ordinary viewer to determine the path the media display would take. Although these multi-media displays were harbingers of the future, they were the creations of professional film makers, advertisers, and media producers.

Nearly thirty years later more sophisticated technology is available to the teacher who can use a small computer, videodisc, compact disc, and other media to engage interactively students of diverse backgrounds. Contemporary teachers bring to the technology *psychological theory* which suggests teaching should address the growth stage of the group (Erickson, Piaget), *learning theory* which directs them to objective driven teaching (Mager) and the pursuit of high level thinking skills (Bloom), and *media theory* which demands they compromise minimally the principle that the most effective way to teach anyone is in direct purposeful experience (Dale). Contemporary teachers, however, need help in displaying the technology and some principles for developing multiscreen bundles.

Two projects in teacher education at Sam Houston State have brought two teams together to determine how to best configure the technology and to create the multimedia bundles. The Model Classroom Committee had to decide on an ideal configuration for a funding grant and the Master Teacher Academy Committee, a team contracted to develop a multi-media bundle for the bicentennial of Sam Houston's birth had to determine from four configurations which could be most cost and learning effective. After reviewing five different configurations both the team and the committee adopted the format of the"Magic Wall," a three large screen configuration using an LCD display of HyperCard from the Mac IISI on the left screen, a large 40 inch television display of the videodisc signal on a central screen, and, a complementary overhead projection of menus and discussion foci for the group interaction on the right screen.

The multi-media bundle team began with three principles in learning theory and discovered others in developing the multi-media program. The first principle was that the the multimedia process must match the growth stage of the group. The second was that any process for mature students must elicit high level thinking skills and the third was the approach must simulate as as closely as possible direct purposeful experience.

The team discovered that any program accessible to different learner stages could be focused by the teacher who uses the multimedia bundle. The narrative would be placed in simple story form to address the young child, and the facilitating teacher could lead an older group to inference, analysis, synthesis, and evaluation by extending the very same content. Since the Dale Cone indicates the most successful teaching is direct purposeful experience, the multi-media presentation could simulate as closely as possible an experience of history divorced from the students by time and space.

The team researched primary documents from Texas history, biographical material, and personal letters . Using HyperCard, the team developed a stack which carried the viewer through "Sam Houston's Texas." The stack evolved, according to plan, as a children's story, entertainment worthy of the observer's attention. But soon it became clear that the medium itself had to move from entertainment to interactive learning. The team first decided to break the narrative at certain points with cards asking the audience a direct question. The question provided a station at which a teacher could involve the students with questions such as "What kind of people lived in early Texas?" and " Is that how Mexicans thought?"

The team secondly punctuated the left screen narrative with *Videodisc buttons* which opened for the viewer a central screen videodisc portrayal of the painter Remington's view of the Native American, the American cowboy, the pioneer and life in the west. As the videodisc provided a professional narration of Remington's views on the central screen the team decided to place on the right screen a series of transparencies either reinforcing the videodisc image or placing it in context. This intervention in the narrative provided the students an opportunity to investigate Remington's perspective, and to compare that with Sam Houston's .

The team thirdly introduced a*text button* on certain cards to give the group the option of observing the complete primary source document summarized in the narrative. A line from John Wharton's letter in the narrative could by button be traced to the actual letter on another card. In the process of creating a research document the group itself had to make decisions about the direction the research would take into content, into learning theory, and into media principles.

Fourth, the team added buttons as mapping strategies. The buttons could be used to move to the videodisc, to primary sources, and even to other parts of the narrative. In another multi-media bundle the team found using *radio buttons* a good way of leaping from one part of the narrative to another so that the buttons became critiquing and mapping tools.

In creating the children's story narrative on HyperCard there was a temptation to use the many gimmicks made available by technology. The new authors fascinated by dissolve, barn doors, checkerboard, and iris open, often introduced so many transitions with easy scripting from card to card that they obscured the message. There was also a tendency to build large text fields since it was so easy to do. If observation of children's books did not provide a principle, the Dale Cone did. Edgar Dale's pyramidal hierarchy placed direct purposeful experience as the most effective way to teach, and words or verbal symbols as the least effective. An economy of words with good support graphics and dissolve transitions provided the least compromise to providing direct purposeful experience.

Animation strategically placed can also alleviate the static nature of the cards. But animation and sound, though fine tools, must support the message and interaction rather than distract from it. Placing animation into a stack for its own sake can distract from the message. Placing music into a program simply because it is available can also distract. Marshall MacLuhan had discovered in the sixties that sound can take away the participatory dimension of the multi-media program. Since the videodisc provided a sound narrative, turning to it meant moving from a participatory mode to an observational mode. However at the end of each videodisc sequence, the facilitating teacher can again engage students in participation.

To insure this participation, the third screen was used to project menus, contexts, questions so that the group could be focused on discussion, and kept on task. A major principle in developing the bundle was to place the teacher at the center , responsible for lifting the group from lower level to higher level thinking. What determines the direction and focus of the multi-media, is the teacher's interactive working with the students. From the initial three screen display the teacher determines the direction the interaction will take, but uses the computer as a director source to drive the other media.

The use of multi-media can be a powerful tool in involving students in discussion, learning, research, and creativity. Bundle authors, however, need to critically assess how the media work if multi-media will be an objective driven and on task experience in teaching. Besides the three basic principles with which they began, the team concluded that the best configuration of the media was the three screen Magic Wall, since the large 6 foot screens were easily visible by any in the group. It made more sense to project on three screens rather than open small windows on one large Mitsubishi monitor. The team also concluded that the basic bundle could build on a simple narrative and extend the media to high level thinking through teacher controls such as video, text, and radio buttons, leading to the central screen, and transparencies on a third screen. The team also concluded that the development of future bundles should begin with a sampling of videodisc in the CAV format to be sure that the central screen had a frozen frame rather than a blue pause found in CLV. The team finally concluded that the heart of the program must be the teacher-student interaction for which the computer provides stations, transitions, and extensions.

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Fostering effective communication during the student teaching experience: The video connection

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Bridging the gap between pedagogical theory and actual classroom practice is a challenge for anyone who trains pre-service undergraduate and graduate teachers, irrespective of grade level or academic discipline. This becomes especially important during the student teaching practicum when pedagogical theory should guide all phases of the student teacher's classroom enterprise, from planning and instruction, to management and evaluation. However, faulty communication among the university supervisor, the student-teacher, and the cooperating teacher frequently undercuts the full potential of applying pedagogical theory to classroom practice.

Before the student teaching practicum begins, it is imperative that the cooperating teacher be cognizant of the expectations of the university supervisor and the student teacher, but this is not always the case. For instance, in being overwhelmed with the daily rigors of classroom instruction, many cooperating teachers frequently cannot keep up with recent pedagogical research—research, for example, which has questioned the effectiveness of many traditional instructional techniques in meeting various pupils' learning styles (Guild & Garger, 1985). Furthermore, because cooperating teachers who are out of touch with pedagogical research may teach the way that they were taught, they frequently are reluctant to have their student-teachers use these new techniques, thereby causing frustration and a breakdown of rapport between the two parties.

While it is critical for cooperating teachers to understand the student-teachers' and university supervisors' expectations regarding the use of various instructional techniques, it is likewise important for cooperating teachers to know how the philosophy of the teacher education program impacts upon the larger decision-making processes of its student-teachers. At La Salle University in Philadelphia, principles of human growth and development undergird all phases of its graduate and undergraduate teacher preparation programs in secondary education as well as its integrated elementary and special education program. Student teachers are taught not to tag their pupils with jargonish labels nor to fit them into arbitrary categories, but instead they are taught to perceive all pupils as individuals, each with her/his own set of physical, intellectual, and psycho-social characteristics. This uniqueness requires student- teachers to accommodate differences and adjust curriculum and instruction to maximize learning of subject matter (Clabaugh & Feden, 1986).

In the past, the university supervisors explained the fine points of this developmental perspective to the cooperating teachers, but its full impact was often obscured by other details such as room assignments, rostering, and non-teaching classroom responsibilities. Consequently, to ensure that cooperating teachers-would understand the developmental perspective, as well as the planning and instructional issues stemming from it, the Department of Education produced two videos, *The Professional Year: An Introduction to Student Teaching in Elementary and Special Education (ESE)* and the *Professional Semester: An Introduction to Student Teaching in Secondary Education (SE).* While video seemed at first to be an ideal medium for presenting all phases of our teacher education programs, it quickly became apparent that such expectations were overly ambitious. To address all of the these phases would entail the production of a series of videos. Thus, we focused on identifying the following themes and topics which, in concert, constitute the linchpin of our programs:

- Department Philosophy: Developmental Perspective
- Professional Experience: Policies and Procedures and Procedures
- Orientation: Field Placement Communication Rapport
- Conferencing: Structure and Expectations

Window on Reality: Rationale for Using Video

Video technology is especially suited to meet the need of our student-teaching orientation for many reasons. Both pedagogical theory and practice suggest that instructional video, when used properly, fosters growth in cognitive reflection, especially with regard to teacher decision-making (Sparks-Langer & Colten 1991). This insight is singularly important to us because our entire four year teacher preparation program has been designed to produce classroom decision makers who are not only knowledgeable but also reflective. Moreover, because video has the potential to convey a great deal of information in a relatively brief period of time (through fades, dissolves, and other effects), it becomes an increasingly more appealing mode of communication for teaching professionals who are exceedingly busy and often overburdened.

Videotape can not only assist and supplement oral and written communiques, but it can also "teach" without our having to be physically present. Video is, indeed, an especially flexible medium: tapes can be readily viewed again and again, at virtually any time, in school or at home; and videos can be shared with interested colleagues. Furthermore, a potent form of motion media, video can serve as an engaging advance organizer, one that creates in the viewer's mind "a need to know" (Heinich, Molenda & Russell, 1993). Finally, because video "is designed to produce a realistic image of the world around us" (Heinich, Molenda, and Russell, 1993), the more authentic we make the experiences appear to our audience, the more meaningful our entire program becomes for them.

Once we had made the decision to use video we then set about producing two instructional tapes ourselves. Designed not only to inform, but also to motivate, these tapes were intended to have both a cognitive and an affective impact. Through dramatized performances, our viewers would see and hear the voices of teachers and students, people like themselves who experienced and resolved real life problems, and who had work-a- day, human relationships to establish and maintain. Teacher narratives, in which it is "the teachers themselves whose voices comprise the story... can be powerful force[s] in heightening teachers' awareness of their own professional reasoning" (Sparks-Langer and Colten). Thus, by writing and performing in our own videos, we tried to ensure not only that such realistic voices would be recognized and heard, but also that our audience would more fully appreciate our cooperative efforts.

Finally, video is a powerful "educational prosthetic," a motivating instructional tool that provides not only an overview of our student teaching program, but also an important set of standardized, yet flexible behaviors that our audience can model (Gardner, 1991). By devising multiple routes or "entry points" to La Salle's student teaching practica, we orient cooperating teachers, university supervisors and student-teachers more effectively because we give them a variety of ways to internalize our programs' contents (Gardner, 1991). By diversifying our instructional modes and providing multiple perspectives, our videos foster comprehensive understanding. Since video itself is an iconographic medium, its instructional use reinforces the developmental thrust of our program. As Bruner attests, and we reaffirm, information can — and should —be represented in a variety of meaningful ways (Good & Brophy, 1990).

Video Partners: A Collaborative Process

Teacher educators frequently may not recognize the scope of professional and personal resources available to bring new ideas into fruition. Consequently, innovative concepts often go no further than the informal discussion level. The following framework is presented to demonstrate the collaborative process that was used to bring one of these "wonderful but we can't do that" ideas to completion. *We knew what we wanted* to communicate to our cooperating teachers, but we did not have the technical expertise to produce quality videotapes. It was at this point that a collaborative venture was required. Obviously, the following process is not university specific and could be modified to suit diverse teacher education programs. The process included three phases:

Phase One: Pre-Production

- Problem Clarification (Spring 1992). During this period the directors of the ESE and SE programs met to determine generic and program specific issues to be developed in a video. It was determined that although there was a department philosophy guiding both programs, there were program specific issues that needed to be handled separately. As a result, the need for two program specific videos was identified.

- Script Writing and Mock Video (May, 1992). A four hour script writing session focused on clarifying and extending topics to be included in the videos: department philosophy, program specific information, field placement orientation and conferencing with the cooperating teacher. Script writing occurred in conjunction with information videotaping of proposed scenes. The videotaped scenes provided corrective visual feedback to refocus direction, to clarify issues, to underscore limitations, and to suggest additional creative possibilities.
- Technical Review (May, 1992). A third member of the education department with media expertise analyzed the initial script and mock video efforts to determine the feasibility of the project. Extensive deliberations focused on topics such as project goal, intended audience, video shelf-life, deadlines, and the establishment of a collaborative link with available university personnel who possessed the necessary knowledge of and experience with video production.
- Collaborative Conferences and Re-writes (May 20, June 16, 1992). The initial conference began with a technical review of the baseline script and mock video by the education department team and the technical team, including a faculty member from the Department of Communication, the Director of Audio-visual Services, and the Video Network Coordinator. Each collaborative conference led to script re-writes, to subsequent technical reviews, and to line-by-line analysis and discussion by the education and technical team. The six meetings centered on integrating the philosophical and practical themes deemed essential by the education team with the high impact video medium issues recognized by the technical team. In all, six people representing four different university departments were part of the collaborative process.
- Talent and Budget (Spring and Summer, 1992) At the suggestion of the video director, the education team at first considered using professional actors to play the roles of the respective program directors and using polished amateurs to act as students. Instead, we decided to have the actual education department program directors play themselves and likewise to have La Salle education majors participate as students. Because each program director would be familiar with her/his program, each would bring a sense of spontaneity to the script, which at times was infused with ad lib comments that contributed factual accuracy and enhanced verisimilitude. Similarly, seven students were selected because of their knowledge of and successful experience in either the secondary or the elementary and special education program. In addition, the student-actors, represented a balance in terms of gender, race, and ethnicity.

  The overall video project was completely funded by the university. We submitted to the Provost a line-item budget that included stipends for students as well as faculty members on the education and the technical teams. Additional monies were provided for refreshments, the technical crew for work beyond their contract hours, and bulk duplication of the two tapes.

Phase Two: Production

- Video Shoot and Editing (June 19 - June 20, 1992). The actual hooting of the two videos took one and one-half days. To consolidate effort and reduce cost, the two tapes were built around a series of generic scenes emphasizing common themes and/or concerns. Program specific issues were taped separately and edited into final versions of each tape.

  The video was shot in the university's television studio which was equipped with three cameras, a switcher, an audio mixing board, a special effects generator, and preexisting sets. The TV studio is primarily used for everyday classroom instruction by the Communication's Department. With the Communication Department Chairs permission, the studio was reserved on a Friday and Saturday when no classes were scheduled.

  Each camera needed an operator. In addition, audio and visual engineers worked within a soundproof director's booth. During the shoot, the video director, a professor in the Department of Communication who teacher TV production, orchestrated the entire "shoot" which included giving tips to actors concerning voice intonation, blocking the actors' movements, positioning cameras, establishing appropriate mood, attending to lighting, and setting the stage.

Phase Three: Post-Production

- Editing. The director served as the video editor. Using master tapes, he edited raw footage to form two twenty minute tapes. Titles and credits, however, were computer generated by the video network coordinator who doubled as assistant director.
- Field Distribution (Fall, 1992 and Spring, 1993). The video was shown to student teachers in each program as an advance organizer during their orientation to the student teaching experience. Field supervisors in the ESE and SE programs used their own discretion to present the respective videos to the cooperating teachers. Each supervisor was asked to make the cooperating teacher aware of the video and request that the teacher view the tape and discuss questions that may arise.

- Analysis (Spring and Summer,1993). A series of questionnaires were distributed to student teachers, cooperating teachers and supervisors. Questionnaire responses will be analyzed to ascertain video impact on fostering effective communication.

Conclusions

The success of this project proceeded from the collaborative effort of many people. With us there was no bureaucratic inertia. Unlike Robert Frost's (1936) ants "Whose work it is to find out God/And the nature of time and space," we were not "thoroughly departmental.n No one stood "round to stare." Each member brought personal and professional expertise to form a unified team to reach an identified goal: the production of two education videos.

At La Salle University, where "teaching comes first," it is common for clusters of faculty to engage in collaborative inquiry in order to foster improvement of university teaching. Further, it is common for professionals from various campus program and offices to work closely with education faculty in providing special topic seminars for our students. Consequently, for us at La Salle, it was no surprise to have focused collaboration across departments in producing videos that would enhance the effectiveness of the student teaching practicum, the capstone experience in the education of our student teachers.

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Inexpensive, new technology (PhotoCD) centerpieces: Southwestern College's bilingual, interactive Macintosh orientation to the College Library

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Many students who begin a program of studies at institutions of higher education fail to complete them because they are unfamiliar with both the library and the principles of library research. This inexperience and lack of research skills presents a serious impediment to success both at Southwestern College and where applicable, their future educational success. A solid foundation of library understanding and skills can only be developed in a user -friendly environment, if these skills are not honed within the library it is unlikely they will be developed elsewhere. Unfortunately, the library in many cases is not viewed as user-friendly. If these students are to be successful they must be given access to information; they must understand how it is collected, stored, and disseminated. Many steps are being taken in libraries throughout the United States to remedy this, our project is one of these many.

To correct this deficiency, we work to acquaint our clientele with the most essential basics of library research in one-hour bibliographic instruction classes, arranged by individual instructors and offered as a regular part of the classroom instructional program. The librarians are currently conducting approximately 300 of these one-hour sessions per academic year. In addition a one-unit class is offered in the honing of library skills. The enrollment at the college has doubled since the number of full-time librarians last increased. An on-line (Dynix, Inc.) automated catalog and CD-ROM indexes have been added, often requiring individual orientations, which take additional staff time. Given these facts and a highly diverse, multicultural user group, a question arises; how can a fixed number of librarians provide the personalized service that is needed when it is needed? Even though this class is extremely successful it does not reach all students who are in need of these skills. Our quest is one that seeks the student that is unaware of his/her need for these skills. Instead we seem to get the bulk of the students in one on one instruction encounters which are not wholly satisfying for the student or the librarian.

While the in-class orientation sessions and the credit class are worthwhile and positive programs, they have not been the perfect solution to our growing and serious problem. Those students who cannot, for whatever reason attend these class sessions remain ignorant of these essential academic research skills. Also, because of space limitations within the library building it is impractical to guide the students through actual library collections. Thus, while they may gain some familiarity with the basic theory of library research, they remain unfamiliar with the physical arrangement of the library itself. Lastly, the necessity of presenting large amounts of information within the constraints of the one-hour session precludes the possibility of spending much time with individual students. In particular, this negatively affects those students whose native language is Spanish or, and who may consequently have difficulty assimilating the principles presented in such accelerated, compressed programs of instruction.

The Instructional Resources division oversees the Library and the LRC which houses microcomputer labs and an AV production area. This division in addition to striving to integrate the newer technologies into the college's curricula is creating a Macintosh based interactive videodisc with equipment and an orientation provided by Southwestern's Matriculation funds. An interactive, multimedia library skills tutorial based on the Southwestern College Library and freely accessible to students during regular library hours would help solve these problems. The focus of this is to improve the library skills of the Southwestern College library user by means of an always available standalone technology which can also be used as a supplementary resource to improve existing library instruction methods as outlined above. This type of system would be an ideal partner to the campus orientation program which is being developed to guide new students through the campus facility.

The library will be one location for a Macintosh IIsi system equipped with a videodisc player for the campus orientation program. Since expertise can be provided within its own division, the librarians first examined the videodisc format as an answer to their orientation problem. But, the pressing of the first videodisc costs about $2500. Moreover, the program the librarians envisioned did not require full motion video of a videodisc, only a few score photo-quality images would be needed to supplement the text, graphics and sound capabilities of the Macintosh station.

Fortunately, the recent introduction of the Kodak PhotoCD technology makes a perfect fit to the librarians' problem. For under $50, a local Kodak photofinisher will transfer up to 100 slides to a PhotoCD in a few days time. The PhotoCD can then be played by one of several inexpensive players available today either by remote control or by computer control. By adding such a player to the already planned campus orientation station, library users will be able to interact seamlessly with campus and library information. The MacIIsi will provide audio explanations by a librarian. With the assistance of the college's translator, a Spanish language version will be produced simultaneously. Also, an additional player and duplicate of the produced PhotoCD will provide enhancement to existing course and group orientation sessions.

Those students unable to attend bibliographic instruction classes would not be lost within the system, but rather integrated into it. They would be able to learn much of the basic material by working with the interactive tutorial. Also, the use of the PhotoCD technology would provide students with a visual, physical awareness of the various areas and collections within the library. To serve our multicultural community, a toggle between the English and Spanish texts will be available within the interactive tutorial. Used at an unhurried pace the these critical academic skills available to more students. Such a system would allow those students who desire to use the system at a slower pace to do so. This would facilitate a broader base to improve comprehension, as well as a refresher course for the instruction orientations provided by the library faculty.

The interactive library tutorial will improve educational quality by allowing the student to retrieve the information needed to complete classroom assignments, and to have information close at hand for personal, school, business, and quality of life. In addition, it also promotes the educational quality of the students by allowing them problem solving abilities not currently in place on any library system. We would not only by promoting quality of instruction, but promoting excellence within and without the classroom. It has been proven that where the student is encouraged the institution retains a higher percentage of students. Hence the matriculation function is enhanced, as is the transfer function.

The focus of this grant is to serve the student population in a ways heretofore unavailable to them. A system as suggested would produce a 'user-friendly' environment which could be placed at any location on campus—in the library, in the classroom, or as an introduction to the Southwestern College Library by those who seek to promote the college and its beneficial services.

Educational Services Addressed by this Proposal

The project is funded by the California Community Colleges Chancellor's Offices's Fund for Instructional Improvement and is designed to positively impact all six of the funding priority areas as authorized by California Assembly Bill 1173 (AB 1173). The primary purpose of the project is to utilize 'non-traditional forms of instruction' to enhance services to all users of the library, while freeing the librarians to concentrate on more complex interaction with the student. The program will also appeal to the 'special learning needs of the educationally disadvantaged student' through its multi-modal presentation. Also featured within this is the Spanish and English language versions. Its constant availability will offer continuous service for 'new clientele including older, and working adults. A clone of the standalone disc will be used in the Library 110 class; its use there will 'improve the library's traditional instruction program. The product when used by faculty and staff will aid in their 'brush up' of library skills. In addition to AB 1173 considerations there will be several areas of the 1992-93 Basic Agenda Priorities addressed.

Specific Problems Being Addressed in the Proposal

As were previously mentioned there are a number of opportunities that can be grasped by the development of this product. The problem of too many students and not enough librarians is one that many institutions have. Southwestern College currently enrolls approximately 17,000 students per semester, while only having 3 full-time librarians. Secondly, the Matriculation focus of the campus requires that all new students be oriented to the campus. This also demands that they become familiar with the library and its functions. Thirdly, there is an on demand need for all users, faculty, students or staff, to have access to library information. Fourthly, our multicultural campus[1] requires a diverse approach to learning as well as a multimodal presentation. Fifthly, it is widely recognized that in order for a student to have success in college, they must have access to information, no matter what form that it is presented to them. This translates to a well rounded knowledge of the library and what is in it. Lastly, the faculty need to be given the unique opportunity to use newer technologies for the maximum benefit of their students.

While seeking for solutions to these problems, an extensive literature search was undertaken. Several alternatives to our plan were given consideration. Principle among them were models from DeAnza College's Campus Orientation Videodisc.

Our plan is to develop information kiosks located throughout the campus which would contain the balance of information included in our traditional class. Students could then access this information whenever it is most useful and convenient for *them*. We believe the advantages of this self-paced orientation include: easy and timely access, periodic testing and remediation, part-time and evening students are able to get oriented at their convenience, counselors are free to preform professional duties other than the dissemination of information.[2]

Other models, most notably, Southwest Missouri State University[3] and Ohio State University[4] were studied and reviewed for their applicability to Southwestern's needs. While each has its appealing aspects a relatively new process was decided on, the PhotoCD which was being developed by Kodak. At this point, November 1992, the PhotoCD player has be obtained and a first series of library photos have been pressed on the PhotoCD. The next objective is to integrate via a software package known as Macromind Director and the standard HyperCard package the PhotoCD and the library information. While this is being done the various screens are being designed and tested to answer specific questions concerning the library and how to function within it. We anticipate that this will proceed with a minimum of headaches, however ample time has been scheduled to allow for the unforeseen.

Project Impact

The immediate impact of the completed project will be that library users will have continual access to an effective and efficient means of learning basic skills necessary to best utilize the library. Its multimedia nature will appeal to the diverse learning styles of our multicultural student body. By providing a path for users to link academic knowledge and learning outside the classroom, the problem solving abilities of our clients will be improved. The product when added to the existing orientation station will further satisfy the matriculation requirement to orient all new students to all the services of the college. As the PhotoCD package frees the librarians to concentrate on more complex tasks the student will be able to progress at a pace designated by themselves. The long term effect will continue to be of value as Southwestern works to take advantage of the benefits offered by the new technologies.

All colleges in the system face the burden of orienting thousands of students each year to their particular library's configuration of services. Most work with a combination of group and individual sessions supported by text materials. Others use some form of technology from video or audio tapes to computer assisted instruction. Our project lays the groundwork for a new kind of pathway for orientations. As mentioned previously, the new PhotoCD concept is quick and very inexpensive, providing an easy way to incorporate technology to existing programs to bring the maximum number of library users the help that they need. The new technology will not replace a very successful program of classroom orientation, nor will it replace the need for one on one encounters with the Reference Librarian. What it will do is supplement known information with a comprehensive program of instruction.

Project Evaluation and Dissemination

Evaluation of the project effectiveness will take place by the involved librarians, the staff and most importantly by the students who use the product. Pretest and posttests are being designed taking into account how much the user already knew about library research as well seeking input from those users with no previous library knowledge. Discrepancy analysis will be a basic technique used to assess consistency between pre and posttest outcomes. A project log will be maintained by the project staff to provide an ongoing record of project activities, revisions and outcomes.

Project reports will be distributed upon request. In addition the Macromind Director software would be available and might serve as a template for other libraries, thereby cutting development time substantially. The PhotoCD itself is replicable, but somewhat costly (approximately $30). However, as the material it contains is unique to the Southwestern College Library, other libraries would certainly prefer to create their own discs.

The college is committed to disseminating the project results to any community college within California through the Chancellor's Office network.

Conclusion

The PhotoCD product as being developed at the Southwestern College Library will be an inexpensive, effective means of allowing students to gather information on information gathering. Because it is multimedia it will appeal to a population that is diverse with varied learning styles. When this product comes online it will become a compliment to the in-class orientations that are already a vital part of the library's instructional program. It is meant to simple to use as well as comprehensive. For these reasons it is felt that the product will be a success.

Endnotes

[1] Campus statistics on population currently indicate: 47% Hispanic, 11% Filipino, 8% Black, 2% or less are American Indian, and the balance is White.

[2] from the DeAnza College self-description (Handout next to system). DeAnza College, Cupertino, California.

[3] *Query: An information source on Administrative Computing*, Fall 1991, p. 11.

[4] *Query: An information source on Administrative Computing*, Fall 1991, p. 14-15.

CONCEPTS & PROCEDURES

Section Editors:
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The collection of papers in this section center around two themes, pre-service/in-service education and laboratory and classroom design. John Watkins of Texas Lutheran College poses an interesting lead off question—Technology and Education: Are they really compatible? In his conclusions, Watkins laments that the "...application and use of educational technology... is at best a piecemeal and uncoordinated effort," characterized by excellence in some districts and anachronistic methods in neighboring districts. As a top priority, he argues, all teachers must be provided with a computer, appropriate software, and the training necessary to make good use of it.

In *Teaching Teachers to Evaluate Software: A system and an example*, Cleborne Maddux of the University of Nevada at Reno expands upon a software classification paradigm which he developed with Cummings, Johnson, and Willis. Software described as Type I is characterized by (1) relatively passive involvement on the part of the user, (2) limited interaction between the user and the machine, and (3) the capabilities of the program can be observed in a short time span (10 minutes or less). Drill and practice packages are typical of Type I applications. By contrast, Type II software is characterized by (1) active involvement, (2) user, rather than machine determined interaction, and (3) a learning curve which requires days or weeks of exploration to determine all capabilities of. Examples of Type II software are word processing, spreadsheets, and data base packages. Maddux argues for increased utilization of Type II software despite the obvious investment which must be made in teacher preparation; the rewards, he asserts, can be great. As an example, Maddux cites the use of computer software to assist students in writing Cinquain poetry. The code for the program, written in Logowriter, is incorporated into the paper.

In *Using Technology in the Classroom: Today and Tomorrow*, Tony Mitchell of St. Cloud State University and Marcin Paprzycki of the University of Texas of the Permian Basin first considers the nature of computer instruction in pre-service curricula, and proceeds to describe a course under development at St. Cloud State. They argue that the use of networks as both a communication and instructional tool is necessary to prepare teachers for the classroom of tomorrow.

Nada Mach of California State University—Dominguez Hills reports the results of an effort on twenty California State University campuses to produce a manual entitled Computers in the Curriculum: Exercises for Integrating Technology into Instruction. Mach's paper, entitled *A Novel Database Lesson for Pre-service and In-*

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service Secondary Teachers presents a detailed lesson on database design which emerged from that effort.

In *Establishing a New Course: Design and Presentation of Information*, Joyce Kupsch of California State Polytechnic University—Pomona, describes a new college course aimed at examining the components of a successful presentation. The use of a desktop presentation package is a central element of the course. Kupsh describes the need for the course together with a description of its content and assignments.

Robert Sanche, Leonard Haines and Gladene Robertson of the University of Saskatchewan describe the development of *AIMS Co-Planner*, a three-year development effort to produce a CSI (Computer Supported Instruction) package for use as special education students are mainstreamed, but with applicability elsewhere. CSI, the authors describe, is more closely related to CMI (Computer Managed Instruction), than to CAI (Computer Assisted Instruction).

On the periphery of this group of papers lies *Copyright: Rights and Liabilities of Authors and Users of Multimedia Presentations* by Diane and Michael Hoadley of the University of South Dakota. The authors present a well-organized description of the history and evolution of the copyright law, and its application in an educational setting. Recent advances in technology which make it possible for computer users to capture sound and video and to repackage it in a multimedia presentation raise interesting and potentially vexing copyright issues.

The second group of papers center around the creation of computer and multimedia labs or classrooms. In *Helping Faculty to Cope With the Classroom in the Year 2000: How To Get a Head Start*, Len Proctor of the University of Saskatchewan describes the design and implementation of a computer classroom for use by the Education Department at that institution.

Judy Lee of Southeastern Louisiana University follows with *The ABC's of Designing and Developing a Media Production Laboratory for Education Majors*. A three phase design introduces students to equipment of increasing sophistication as they progress through the program.

The final selection, *Choosing Computer Hardware for Instruction: Asking the Right Questions*, by Shirley Gartmann of the University of Wisconsin at Whitewater presents a framework for making appropriate equipment selections.

Technology and education: Are they really compatible?

John Watkins
Texas Lutheran College

Popular technology magazines such as MACWORLD (Sept 1992) are now reporting on the heavy investment that America has made during the last decade on the installation of personal computers in our schools. This investment is no surprise to the educational community, but perhaps the findings of MACWORLD are. The cover of this widely read computer magazine states "America's Shame". On the cover is the picture of a student asleep at a computer. The computers screen is covered with a sign that reads "Computer Broken Do Not Use". Have the people at MACWORLD found something that we in education have missed, or have we just not been looking?

In another technology periodical, MacWEEK (Sept, 92, pp 42) Jean Louis Gassee, formally of Apple Computer, comments that we really do not have a good control group for our computers in education experiments. Gassee asks, where have we spent the same kind of money and resources for a non-computer school as we have for those that received computers? Where have we empowered the teachers in the same way? In reviewing journals such as T.H.E. (Technological Horizons in Education), Apple's Syllabus, and others, I find that we have usually reported on our successes rather than our failures. Even though MACWORLD is a popular non-refereed magazine, the comments and observations in the articles deserve some thought.

According to Lewis Perelman (1992), in his book *School's Out*, there is a learning revolution going on and its not occurring in the classroom. Perelman states, "A new wave of knowledge technology has put the access to enhanced learning at our fingertips." Perelman and others are not just talking and writing about computers, they are talking about a whole new way of learning that allows access to the world through the use of technology. This technology ranges from normal presentation media through computer learning, in all of its various forms, to distance learning. None of this necessarily requires the use of the classroom or the accepted stereotypical version of the teacher. However, to accommodate this new way of learning, one of the most important requirements will be talented trained people to facilitate learning.

As Allan Ornstein points out in his article *Making Effective Use of Computer Technology* (1992), computers and other new devices such as laser disks have the potential for making a far greater impact in the educational technology field than at any time in the past. The new integrated technology available today offers greater student and teacher interaction than ever before. If we include older technology such as television, 16mm movies, filmstrip projectors, and the like, we really do have the ability and opportunity to make an impact on learning.

Television is a technology that has been around for almost fifty years, and has never fully met its educational potential. It is used very successfully to sell everything from automobiles to Malcom X. Unfortunately, education and learning have little immediate commercial value and thus are often ignored by those that should offer or watch this type of programing. An exception to this is the Channel One system by Whittle, bringing news and commercials into the schools from fifth grade through high school. Programing offered on the Public Broadcasting System (PBS), The Discovery channel, and the Learning channel, to name a few, provide interesting and informative programs that often have direct applicability to a number of content areas in the classroom.

One of the problems highlighted by John Goodlad's study of the education of educators is the disconnection between the college and university systems and the public schools. In *At the Crossroads: Linking Teacher Education Renewal to School Reform* (Finney, in press), Finney finds that many states are making attempts to reform the school without any serious attention to the undergraduate education of future teachers. These reforms will certainly effect how we prepare our future teachers to utilize technology in their classrooms. As has been pointed out in many articles and political speeches, many states are hard pressed financially and education departments at colleges and universities have never been over funded. Perhaps the proper place to begin the reform in the use of technology is with the teacher educators themselves, by properly funding some of the programs that are needed.

What have we accomplished, where do we go from here, and how can we make it better? Statistics from the United States Department of Education indicate that more than fifty percent of children in grades one through eight use a computer in their school, no matter the geographic location, cultural makeup of the population, or wealth of the school system. The high schools also have an installed base of computers which is often associated with business education and keyboarding. Unfortunately, many schools install computers in classrooms or labs without thought to the necessary training of the teacher that is supposed to make use of them. We often install only one computer in a classroom and expect the teacher to use it in a supplemental role.

In many schools, we find equipment that is obsolete, underused, or unused for any educational purpose at all. These resources have cost us millions of dollars and they are being wasted. Is this the case for all schools? Of course not, in many schools these devices are in use all day long with children busy doing tasks that help them to learn and teachers to teach. What then is the difference between the school with the computers sitting unused and the school that is making use of the equipment for education?

Educational institutions that make effective use of

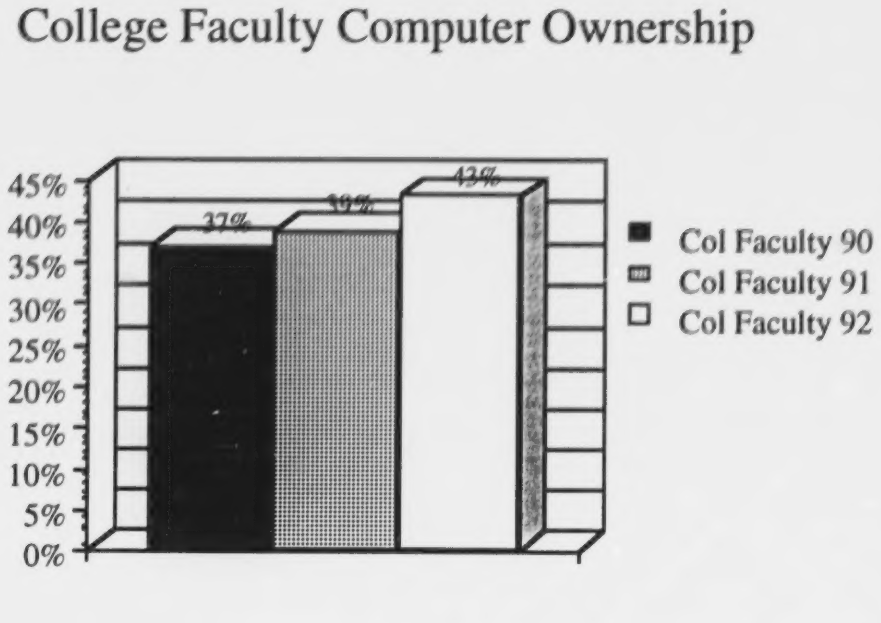

Figure 1

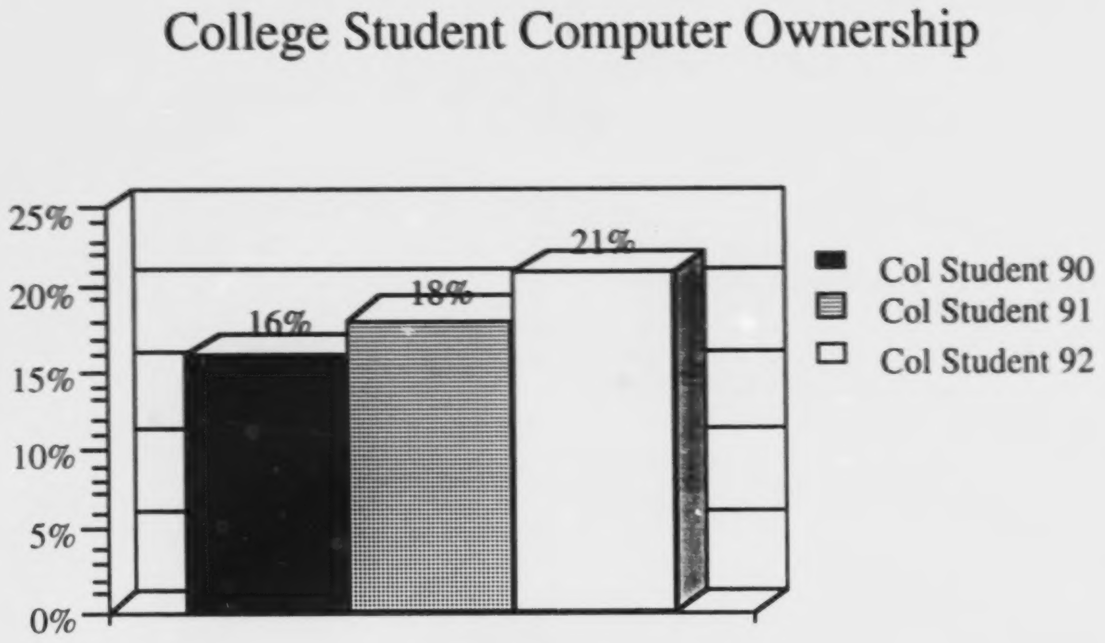

Figure 2

technology have certain things in common, such as a long term commitment of support for hardware, software, and training. Technologically and educationally successful schools utilize all available technology and know that computers are not the only technology available. Other presentation media, such as VCRs, Laser disk players, slide projectors, etc. have also been integrated into the curriculum. These schools incorporate the use of technology as an integral part of the educational system, not as an add-on or supplemental activity. Successful schools also continue to make an investment in new machines, software, and educator training as their older equipment and software becomes obsolete, is replaced, and a new training cycle begins. These schools also have teacher inservice on the use of technology to help the staff feel comfortable in using these devices. All of the school is brought on line through a long term investment in both the students and the teachers.

Another large resource for learning exists at the various colleges and universities that make up the higher education system in this country. As is shown in Figure 1, the faculties of our universities and colleges are rapidly purchasing computers and using technology to help them with their research efforts. these educators are also making use of telecommunications and e-mail to conference with their peers, but how many pass on these uses of technology to students?

Data from EDUCOM's annual survey as reported by DeLoughry (1992) in The Chronicle of Higher Education, indicate that both college faculty members and their students (figure 2) are purchasing computers at an increasing rate.

Data from Arkansas taken in 1989 and 1990, (Watkins 1990) indicates that 26% of the high school students surveyed owned their own computers or had access to one in their homes. If high school student ownership of computers parallels that of higher education, we will see an increase in computer literate students coming into our college classes. (Figure 3)

Many of our students in elementary, secondary, and college classrooms, continue to plod through yet another drill and practice routine which research has proven to be the least effective method of using computer aided instruction (CAI). The results of a random survey of 83 science teachers in Arkansas on the uses of computers and programs are tabulated in Table 1 (Watkins, 1990). Observations at elementary, high schools, and colleges in Texas this year indicate that similar results would be obtained in that state, with perhaps an increase in the use of drill and practice software at the elementary level.

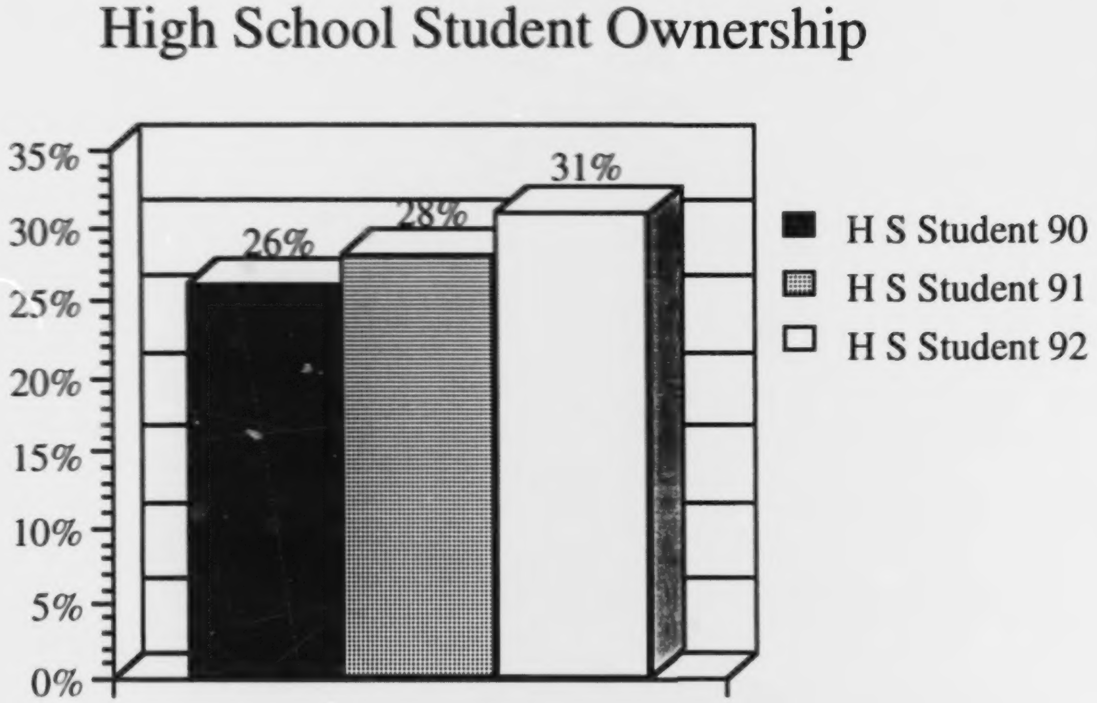

Figure 3

Table 1
Teacher Utilization of Computer Applications

Method	Respondents	Percentage %
Drill and practice	26	31
Simulation	21	25
Word processing	15	18
Data base	8	10
Interactive video	7	8
Lab monitoring	4	5
Other (grade book)	2	2

A survey of Arkansas science teachers taken in 1990, asked if they had ever attended an inservice on using computers for educational purposes, and if so, how useful the inservice was in their professional growth. Survey results show that 51 of 99 (52%) teachers indicated that they had attended an inservice. The usefulness of this training is shown in Table 2. It is of interest that those teachers indicating little use for the inservice, had no computers in their classrooms.

Table 2
Teacher Inservice Rating

Rating	Respondent	Percent
1 Very useful	13	25%
2	4	8%
3 Useful	18	35%
4	8	16%
5 No use	8	16%

In a review of the literature on teachers' attitudes toward computers, Dupagne and Krendle (1992) found that in general, teachers express a positive attitude toward the implementation of computers in their classrooms and the curriculum. The main reservations and concerns were voiced in the availability of hardware, the suitability of software, and the lack of training available to preservice and inservice teachers. The authors point out that their review of the literature suggests that teacher training is the critical component for the successful implementation of any computer project. Inservice training and workshops for teachers need to emphasize better coordination between teachers and administrators. These comments are particularly true now, with the integration of other technological devices such as the CD Rom, multi-media presentation, and level three (computer interfaced) laser disk player into the classroom.

Many states are now setting up online connections for teachers, students, and other educational professionals that allow them to share lesson plans, educational information and other data for use in the classroom and research. The state of Texas has set up TENET (Texas Education Network) which allows educators, administrators, and students to communicate around the world through a connection to Internet and Bitnet. Teachers can receive training on how to use this program through regional training centers throughout the state. Other states have or are setting up similar distance learning programs.

The opportunities in distance learning are literally worldwide. Teachers and classes can now communicate in real-time with others around the world. Unfortunately, once again very few preservice and inservice teachers are provided with information on this opportunity for learning. Also, while many schools do have at least the minimum number of computers to participate in this type of learning, it is often very difficult to get the necessary phone line installed.

Many colleges and universities that are involved in the education of preservice and graduate teachers are now going through the process of incorporation of courses in technology and how to use it into their curriculum. The state of Texas and others have been providing funds in the form of grants for the development of pilot and research programs into the effective use of educational technology for the past two decades. These programs are necessary, but are of limited scope when it comes to the practical details of implementing their findings state wide or at the national level.

Some of the major concerns of the Guadalupe Valley Educational Collaborative Advisory Committee, a group of industry, college and public school professionals in the San Antonio and Austin area in Texas are:

1. education in the use of educational technology for preservice teachers at the college or university level;
2. well prepared continuing inservice instruction for teachers in basic and advanced uses of educational technology;
3. continuing access to equipment and programs for teachers after inservice training;
4. proper long term funding from local, state and national levels for research and the implementation of educational technology;
5. the major focus areas for the implementation of the use of educational technology be in the areas of science and mathematics;
6. that colleges and universities collaborate with public schools on the implementation of training in the use of technology for education at the teacher preparation and inservice level;
7. that the advantages of sharing equipment and training resources be explored;
8. that the advantages for the use of educational technology be clearly demonstrated to preservice and inservice teachers;
9. that any adoption of technology requires planning and ongoing commitment to maintain both the technology and the training of personal;
10. both preservice and inservice teachers need to know about both MS-DOS, MacIntosh and OS/2 based platforms plus older systems such as the Apple II series.

Conclusions

Successful incorporation of technology into the educational system at all levels must include a long term commitment to continual upgrading of hardware, software, and the training of all involved. This can be accomplished at either the school itself, a regional center, or a cooperating college or university. The colleges and universities have a responsibility in educating both inservice and future teachers in the efficient use of technology for all levels of classroom teaching.

The application and use of educational technology in the United States is at best a piecemeal and uncoordinated effort that is usually created and implemented at the local level. Some of these efforts show us what might be, and are often reported as showing that the use of technology is alive and well in America. However, the next school district may still be using just blackboards, without even an overhead projector because of funding problems.

As Deborah Branscumm (1992) points out, "Every state, every school district, and every school should develop plans in consultation with teachers, students, parents, and school administrators to integrate computers and related technology into the curriculum".

The general public, private industry, and public institutions have a large installed base of relatively modern computers. This base could be used partially to supplement our educational base until it is standardized and modernized.

Our first priority should be to provide inservice training to our teachers and provide each with a modern computer and software to use on it. At the same time modernize our teacher training institutions and their curriculum to include multi-platform training on the use of computers and other available technology for education. At a minimum, this training should include the production, and proper use of, visual media, television, including use of off the air media, and copyright training. This training will then help preservice and inservice teachers integrate technology into their curriculums.

As Mr. Borrell (1992) points out in his commentary in MACWORLD, it would be helpful if the Federal Government would provide leadership in initiating programs and setting some policy standards for how education in the United States is to be conducted.

The Department of Education should commission a survey of all of the states as to the extent of their existing technological base. This data could then be used to provide the necessary national programs and if necessary, materials to utilize both private and public resources for learning.

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Teaching teachers to evaluate software: A system and an example

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A truism of long standing is that the field of educational computing is plagued by an abundance of poor quality software. Lockard, Abrams, and Many (1987) summed up the situation well when they suggested that "Virtually any gathering of educators with computer interests will at some point prompt discussion of the appalling quality of courseware on the market" (p. 177).

Even though educational software quality has improved in recent years, there is evidence that poor quality is still a significant problem. Neill and Neill (1989) publish periodic guides to educational software. Their 1990 edition reports finding many poor programs and identifies only seven percent of the 11,000 titles examined as "excellent." Similarly, the Office of Technology Assessment (1988) interviewed computer coordinators and other public school officials and concluded that software quality is still a major problem.

However, excellent educational software is available, and the problem for educators is devising review and evaluation procedures to ensure that only the best software is selected for purchase. Because the pool of available software is growing rapidly, and because state and local budget crises continue to limit the amount of money schools can use for software purchases, such software evaluation procedures are becoming more critical for teachers and teachers-in-training.

The magnitude of the review, evaluation, and selection dilemma can be seen in light of the fact that at least 2,000 new programs are released each year (Office of Technology Assessment, 1988) to add to the 1990 total of well over 20,000 educational programs (Geisert and Futrell, 1990).

Although many introductory educational computing textbooks include chapters on educational software evaluation and provide sample evaluation forms, most such schemes lack any underlying rationale or systematic approach.

The purpose of this paper is to suggest that software evaluation skills should be carefully taught to teachers and teachers-in-training, and that such skills should be based on a conceptual framework in which software is classified as Type I or Type II software (Maddux & Cummings, 1986; 1987; Maddux, Johnson, & Willis, 1992).

Categorizing Educational Software

Type I software makes it quicker, easier, or otherwise more convenient to continue teaching in traditional ways. Type II software makes new and better teaching methods available - methods that would not be possible without the use of the computer.

Although I believe that Type II software is generally more educationally important than Type I, the reader should not infer that Type I and Type II are synonymous with "bad" and "good." This is so because much traditional teaching is worthwhile and useful. Therefore, software that facilitates its use (Type I) is also worthwhile, and should be part of the inventory of every computer-using teacher.

The reason that I believe that Type II software is more desirable than Type I is related to the relative significance of the educational problems addressed by each type. As will be seen from the discussion that follows this section, Type II software is usually aimed at teaching skills and concepts that most educators would agree are much more significant and much more difficult to teach than are those targeted by Type I software.

This distinction is, I believe, important in software evaluation and selection, and critical in determining the fate of the educational computing movement in general. I have often stated that I believe that the educational computing movement is currently at risk (i.e., Maddux, 1987; Maddux & Johnson, 1989; Maddux, Johnson, & Willis, 1992). I am today more confident than I once was of the general survival and success of educational computing. However, the field is still very much embryonic in its development, and great care must be exercised if we hope to see educational computing accepted as a legitimate and valuable sub-discipline within education and psychology. Although Type I software with its emphasis on traditional teaching and learning is not without merit, I still believe that it is Type II applications that have the potential to legitimize educational technology. My colleagues and I summed up our impressions of Type I and Type II applications as follows:

> Type I computer applications are useful and convenient, and can and should play an important educational role. . . . However, Type I applications by themselves, no matter how well done, cannot justify educational computing to media critics, other educators, school board members, legislators, or the public at large. Type I uses are insufficient because educational computing is too expensive to devote entirely to relatively trivial problems. Although dollar costs continue to decline, computer hardware and software still require substantial financial investment. The less obvious and probably more significant expense is in terms of the time, effort, and enthusiasm of teachers and students. Teachers and students have a limited supply of these ingredients to invest in teaching and learning. If the time, effort, and enthusiasm of either group are devoted to materials and methods that are inefficient or that can only achieve goals of relatively limited importance, such materials and methods are not likely to receive lasting support. Therefore, although excellent Type I applications are to be supported and encouraged, we believe that a balanced, successful educational computing program requires the development and use of both Type I and Type II applications. (Maddux, Johnson, & Willis, 1992, p. 23)

Type I Software

Type I software makes it quicker, easier, or otherwise more convenient to continue teaching in traditional ways. Type I software is highly varied, but usually share one or more of the following characteristics:

1. *Type I software requires and encourages only relatively passive intellectual involvement.* Although such software is interactive, it usually involves and develops rote memory, or highly limited and mechanical responses such as that required for simple arithmetic computation or sight word recognition. Higher order thinking skills are seldom required.
2. *Most of what occurs on the screen has been predetermined by the software developers, including the type of limited interaction between learner and machine.* The learner may be prompted to make certain, limited choices, but the majority of what occurs was decided beforehand by the software designers, rather than by the user.
3. *Everything the software is capable of doing can often be observed in ten minutes or less.* Although different problems may be generated, the format of the problems is either identical throughout, or involves only a few variations.

Some examples of Type I uses of computers include drill and practice, tutorial uses, assessment uses, administrative uses, and computer managed instruction.

Type II Software

Type II software makes new and better teaching methods available - methods that would not be possible without the use of the computer. Although Type II software is even more varied than is Type I, it often shares one or more of the following characteristics:

1. *Type II software requires and encourages relatively active intellectual involvement.* Although both Type I and Type II software is usually interactive, Type II software more often involves higher order thinking skills and creativity, rather than simple rote memory and mechanical skills. Word processing is an example of Type II software that clearly requires much more complex cognitive involvement than does Type I software such as drill and practice in multiplication facts.
2. *Most of what occurs on the screen is determined by the user, rather than the software developer, and the type of interaction between learner and machine usually involves a highly varied (sometimes unlimited) repertoire of acceptable responses.* Many examples of Type II software (although not all) furnish the user with a blank screen and a powerful way to put a wide

variety of content on that screen. Three good examples of this are word processing, spreadsheets, and data base management software.

3. *It often requires days or weeks of use before everything the software is capable of doing has been observed.* Although not invariably true of Type II applications, this characteristic is one reason that good software reviews of some Type II applications are difficult to find. It is quite easy for busy staff writers to preview a new piece of drill and practice software and write a quick, intelligent review of that software. Since everything that the software can do can often be seen in a matter of minutes, the entire process of preview, including writing the review, may take less than an hour. It is quite another matter to write a perceptive review of a new word processor or a new educational simulation, when the nuances of these programs may take weeks to fully explore.

Examples of Type II software include word processors, electronic spreadsheets, database management software, programming languages, simulations, certain types of problem-solving software, software that provides prosthetic aids for the disabled, graphics software, presentation software, telecommunications software, and writing aids such as spell checkers and outlining software.

For a much more complete discussion of Type I and Type II software see Maddux, Johnson, and Willis (1992). In the next section, an example of Type II software will be presented and discussed. This software is designed to encourage and aid reluctant writers to write a form of poetry called Cinquain.

Why Teach Children to Write Poetry?

Almost everyone agrees that expressive writing is an important skill, and that many of today's students have poor writing skills. In the face of the scandal concerning writing skills, it is difficult to understand why so many teachers neglect the teaching of writing. Even when such programs are implemented, children often get very little practice in expressive writing itself. Silverman, Zigmond, Zimmerman, and Vallecorsa (1981) examined a number of public school writing programs and reported that the average student spent only 25 minutes per day writing, and that 19 minutes of this time was devoted to copying or recopying. (p. 356).

Many computing advocates have suggested that the computer, particularly word processing, could be useful in writing instruction. Although word processing is becoming more common in writing instruction, there is little indication that computers are being used to help instruct children in the writing of poetry.

Poetry should be a part of the writing curriculum for a number of reasons. First, poetry is a highly endangered part of our cultural and intellectual heritage. We all have a responsibility to preserve and pass on this heritage. Even more importantly, reading and writing poetry can be emotionally and intellectually rewarding and provide an important form of personal enjoyment. Like any art form, it contributes to a richer life and a deeper insight into the human condition. Then too, poetry can be an important source of self expression, particularly for reluctant writers, whose academic problems may lead them to avoid other forms of artistic expression.

Using the Computer to Help Teach Poetry Writing

Teachers, however, often avoid teaching poetry writing. One reason for this avoidance is that by the time children (especially reluctant writers) are in the fifth or sixth grade, many are emphatically hostile toward poetry. This hostility is frequently due to past difficulties with the mechanics of verse (rhyme, meter, etc.) as well as the physical difficulties of writing in general (penmanship, spelling, neatness, etc.). A major problem is that some teachers overemphasize the importance of structure such as rhyme and meter, and problem learners are so overwhelmed with the mechanics that they never experience the creative enjoyment of expression. They feel so bound by the structure that they neglect the meaning.

Obviously, the computer has the potential to eliminate or reduce the frustrations caused by poor penmanship, deficient spelling, and a lack of neatness. Word processing and a good spell checker can open new worlds of expression to children with the problems listed above. It is also possible to use the computer to help de-emphasize the mechanics of rhyme and meter.

Even without access to computers, reluctant writers can be introduced to any of a number of forms of poetry that do not rely on these technical characteristics.

Haiku and Tanka are two examples that have been adapted from Japanese forms. Instead of relying on verse and meter, these forms require a specific number of lines and syllables. Tanka is made up of five lines, with 5, 7, 5, 7, and 7 syllables in each line, respectively. Haiku is made up of three lines, with 5, 7, and 5 syllables in each line, respectively. Haiku and Tanka usually deal with nature and avoid contain violence or images that include damage to nature. Rhyme plays no role in either form.

Computers and Cinquain Poems

Another form of poetry that does not rely on rhyme or meter is Cinquain, developed in 1922 by Adelaide Crapsey (1922). An adaptation of Cinquain is often used with children. Each line of a Cinquain contains a predetermined number of words, and each line performs a specific role in the poem:

1. The first line is a noun that names the subject of the poem.
2. The second line is two words, usually adjectives, that

describe the subject.

3. The third line is three words (often ending in "ing") that express an action.
4. The fourth line is four words that express feeling.
5. The fifth line is a single word that is another word for the subject of the poem.

The following are two examples written by fifth grade learning disabled students:

Stars
Bright, alive
Twinkling, sparkling, shining
Are we this small?
Brothers

Sixties
Fast, Loud
Marching, Demonstrating, Exploring
Anger, Excitement, Sadness, Joy
Change

Appendix A presents the LogoWriter 2.0 code (for MS- DOS) for an original program to help reluctant writers learn to write, and then to actually produce Cinquain poems. The program has both a Type I and a Type II component. The Type I program is a tutorial designed to teach the mechanics of the poem and to present an example, while the Type II component is an on-line composition tool that will lead the user, line-by line, through the process of writing a Cinquain.

As the program prompts for each line, it displays a reminder of the function of that line. The program provides for unlimited revision, and any line may be revised or rewritten at any time, with full function reminders present. When the poem is complete, the program asks if a printout is desired.

The program could be used as on a stand-alone basis, or in conjunction with word processors, spell checkers, etc. For example, students could save the poem as a text file, then load it into any word processor and the dictionary or thesaurus could be accessed. The teacher can also use this program to produce a class collection of poetry.

Categorizing the Cinquain Program

The Cinquain Program has both Type I and Type II components. The tutorial is Type I in nature. It requires some intellectual involvement, but it is really aimed at imparting factual material that can be memorized (number of lines, function of each line, etc.). The interaction between user and machine is predetermined by the designer, and is very limited in content (pushing the space bar, typing "yes" or "no", etc.).

The writing aid, on the other hand, is a Type II application. It requires very active intellectual involvement compared, for example, to that required by a drill and practice program designed to teach math facts. In addition, most of what occurs on the screen is determined by the user, rather than the software developer, and the type of interaction between learner and machine does not involve only a predetermined repertoire of acceptable responses. In fact, the only limitation on what can go into the Cinquain is that imposed by the imagination of the user. The designer of the software has provided only those limitations necessary to preserve the format, rather than the content, of the poem.

It is hoped that the categorization scheme presented in this article, and the software example used to illustrate it will be useful to educators as they think about educational computing, and as they make decisions about how to integrate computers into schools.

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Appendix A

Cinquain for the IBM (LogoWriter 2.0)
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```
TO CINQUAIN
CT HT
PR [THIS SOFTWARE IS DESIGNED TO]
PR [TEACH YOU HOW TO WRITE A FORM]
PR [OF POETRY CALLED "CINQUAIN."]
PR [] PR [DO YOU WANT TO SKIP THE]
PR [INSTRUCTIONS AND EXAMPLES AND GO]
PR [DIRECTLY TO THE PART WHERE YOU]
PR [WRITE YOUR OWN CINQUAIN?]
PR [TYPE YES OR NO]
PR [] PR [] MAKE "A FIRST RL
IFELSE "Y = ITEM 1 :A [CINQWRITE][CINQTOTAL]
END

TO CINQWRITE
WRITE1 WRITE2 WRITE3 WRITE4 WRITE5
CONCLUDE
END

TO WRITE1
CT MAKE "LINE1 [] MAKE "LINE2 []
MAKE "LINE3 [] MAKE "LINE4 []
MAKE "LINE5 []
PR [NOW IT IS TIME FOR YOU TO TRY]
PR [WRITING A CINQUAIN OF YOUR OWN.]
PR [] PR [TYPE A SINGLE WORD NAMING]
PR [THE SUBJECT OF YOUR POEM.]
PR [] PR [] PR []
MAKE "LINE1 RL
PR [] PR [YOU TYPED:]
PR [] PR [] PR [] PR :LINE1
PR [] PR []
PR [DO YOU WANT TO CHANGE YOUR MIND?]
PR [] MAKE "A FIRST RL
IF "Y = ITEM 1 :A [CHANGE] PRESS
END

TO PRESS
PR [] PR []
PR [PRESS ANY KEY TO CONTINUE]
MAKE "A READCHAR
END

TO CHANGE
CT PR [YOU MAY CHANGE ANY OF THE LINES]
PR [THAT YOU HAVE ALREADY WRITTEN.]
PR [] CT REPRINT
PR [ENTER THE NUMBER OF THE LINE]
PR [YOU WANT TO CHANGE:]
PR [] MAKE "CHOICE RL
IF :CHOICE = [1] [EXPLAIN1]
IF :CHOICE = [2] [EXPLAIN2]
IF :CHOICE = [3] [EXPLAIN3]
IF :CHOICE = [4] [EXPLAIN4]
IF :CHOICE = [5] [EXPLAIN5]
PR [ENTER THE NEW LINE OF POETRY:]
PR [] IF :CHOICE = [1] [MAKE "LINE1 RL]
IF :CHOICE = [2] [MAKE "LINE2 RL]
IF :CHOICE = [3] [MAKE "LINE3 RL]
IF :CHOICE = [4] [MAKE "LINE4 RL]
IF :CHOICE = [5] [MAKE "LINE5 RL]
PR [] PR [] PR [] REPRINT PR [] PR []
PR [DO YOU WANT TO CHANGE ANYTHING]
PR [ELSE?] PR [] PR []
MAKE "A FIRST RL
IF "Y = ITEM 1 :A [CHANGE]
END

TO EXPLAIN1
PR [REMEMBER, LINE #1 IS ONE WORD]
PR [THAT EXPLAINS THE SUBJECT OF THE]
PR [POEM.]
END

TO EXPLAIN2
PR [REMEMBER, LINE #2 IS TWO WORDS]
PR [THAT DESCRIBE THE SUBJECT.]
END

TO EXPLAIN3
PR [REMEMBER, LINE #3 IS THREE WORDS]
PR [EXPRESSING ACTION.]
END

TO EXPLAIN4
PR [REMEMBER, LINE #4 IS FOUR WORDS]
PR [EXPRESSING FEELING.]
END

TO EXPLAIN5
PR [REMEMBER, LINE #5 IS ONE WORD]
PR [THAT IS ANOTHER WORD FOR THE]
PR [SUBJECT OF THE POEM.]
END

TO WRITE2
CT REPRINT PR [] PR []
PR [NOW IT IS TIME TO WRITE LINE #2]
PR [] PR []
PR [TYPE TWO WORDS DESCRIBING THE]
PR [SUBJECT OF THE POEM.]
PR [] PR [] PR [] MAKE "LINE2 RL
PR [] PR [YOU TYPED:]
PR [] PR [] PR [] PR :LINE2 PR [] PR []
PR [DO YOU WANT TO CHANGE YOUR MIND?]
PR [] MAKE “A FIRST RL
IF “Y = ITEM 1 :A [CHANGE] PRESS
END

TO REPRINT
PR [HERE IS THE POEM:] PR [] PR []
(PR [LINE #1:] :LINE1 )
(PR [LINE #2:] :LINE2 )
(PR [LINE #3:] :LINE3 )
(PR [LINE #4:] :LINE4 )
(PR [LINE #5:] :LINE5 )
END

TO WRITE3
CT REPRINT
PR [] PR []
PR [NOW IT IS TIME TO WRITE LINE #3]
PR [] PR []
PR [TYPE THREE WORDS EXPRESSING]
PR [ACTION] PR [] PR [] PR []
MAKE “LINE3 RL PR [] PR [YOU TYPED:]
PR [] PR [] PR [] PR :LINE3 PR [] PR []
PR [DO YOU WANT TO CHANGE YOUR MIND?]
PR [] MAKE “A FIRST RL
IF “Y = ITEM 1 :A [CHANGE] PRESS
END

TO WRITE4
CT REPRINT PR [] PR []
PR [NOW IT IS TIME TO WRITE LINE #4]
PR [] PR []
PR [TYPE FOUR WORDS EXPRESSING]
PR [FEELING]
PR [] PR [] PR [] MAKE “LINE4 RL
PR [] PR [YOU TYPED:]
PR [] PR [] PR [] PR :LINE4
PR [] PR []
PR [DO YOU WANT TO CHANGE YOUR MIND?]
PR [] MAKE “A FIRST RL
IF “Y = ITEM 1 :A [CHANGE] PRESS
END

TO WRITE5
CT REPRINT PR [] PR []
PR [NOW IT IS TIME TO WRITE LINE #5.]
PR [] PR []
PR [TYPE ONE WORD THAT IS ANOTHER WORD]
PR [FOR THE SUBJECT OF THE POEM.]
PR [] PR [] PR [] MAKE “LINE5 RL
PR [] PR [YOU TYPED:]
PR [] PR [] PR [] PR :LINE5 PR [] PR []
PR [DO YOU WANT TO CHANGE YOUR MIND?]
PR [] MAKE “A FIRST RL
IF “Y = ITEM 1 :A [CHANGE]
PRESS REPRINT PRESS
END

TO CINQTOTAL
INSTRUCT1 INSTRUCT2 INSTRUCT3 INSTRUCT4
INSTRUCT5 WRITE1 WRITE2 WRITE3 WRITE4
WRITE5 CONCLUDE
END

TO INSTRUCT1
CT PR [“CINQUAIN” IS A FORM OF POETRY]
PR [THAT DOES NOT DEPEND ON RHYME.]
PR [] PR [INSTEAD, EACH LINE DOES SOME-
THING]
PR [DIFFERENT.] PR []
PR [LINE #1 IS ONE WORD THAT NAMES THE]
PR [SUBJECT OF THE POEM.]
PR [] PR [HERE IS AN EXAMPLE:]
PR [] PR [] PR [SIXTIES] PRESS
END

TO INSTRUCT2
CT PR [LINE #2 IS TWO WORDS ( USUALLY]
PR [ADJECTIVES ) THAT DESCRIBE THE]
PR [SUBJECT OF THE POEM.] PR []
PR [HERE IS THE EXAMPLE WITH LINE #2:]
PR [] PR [] PR [SIXTIES] PR [FAST, LOUD]
PRESS
END

TO INSTRUCT3
CT PR [LINE #3 IS THREE ACTION WORDS.]
PR [] PR [HERE IS THE EXAMPLE WITH]
PR [LINE #3 ADDED:] PR [] PR []
PR [SIXTIES] PR [FAST, LOUD]
PR [MARCHING, DEMONSTRATING, EXPLORING]
PRESS
END

TO INSTRUCT4
CT PR [LINE #4 IS FOUR WORDS SHOWING]
PR [FEELING]
PR [HERE IS THE EXAMPLE WITH LINE #4:]
PR [] PR [] PR [SIXTIES]
PR [FAST, LOUD]
PR [MARCHING, DEMONSTRATING, EXPLORING]
PR [ANGER, EXCITEMENT, SADNESS, JOY]
PRESS
END
```

```
TO INSTRUCT5
CT PR [LINE #5 IS A SINGLE WORD THAT]
PR [GIVES ANOTHER WORD FOR THE SUBJECT]
PR [OF THE POEM.]
PR [HERE IS THE ENTIRE CINQUAIN, THIS]
PR [TIME WITH THE LAST LINE ADDED:]
PR [] PR [SIXTIES]
PR [FAST, LOUD]
PR [MARCHING, DEMONSTRATING, EXPLORING]
PR [ANGER, EXCITEMENT, SADNESS, JOY]
PR [CHANGE] PR []
PR [THIS CINQUAIN WAS WRITTEN BY ONE]
PR [OF MY FIFTH GRADE LEARNING]
(PR [DISABLED STUDENTS IN] WORD “1970 “. )
PRESS
END

TO CONCLUDE
PR [] PR [CONGRATULATIONS! YOUR CINQUAIN]
PR [IS FINISHED!]
PR [] PR [WOULD YOU LIKE A]
PR [PRINTOUT OF THE FINISHED POEM?]
PR [] MAKE “Z FIRST RL
IF “Y = ITEM 1 :Z [PR [BE SURE PRINTER]]
IF “Y = ITEM 1 :Z [PR [IS READY.]] PRESS
IF “Y = ITEM 1 :Z [MAKE “B [PR :LINE1 PR :LINE2
PR :LINE3 PR
:LINE4 PR :LINE5]]
IF “Y = ITEM 1 :Z [CT CC RUN :B PRINTTEXT]
PR [] PR [THIS CONCLUDES THIS SESSION]
END
```

Using technology in the classroom: Today and tomorrow

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Introduction

It is expected that the present educational system respond to the current needs of society. Education should also predict what society's future needs might be. One such current need is for individuals, upon completing their education, to be computer literate. If this is the case, one should expect teachers to be computer literate as well. The first part of this paper will examine the extent to which computer literacy is a part of teacher preparation. Second, a course which includes both traditional and newer uses for computers in educational settings is proposed. Finally, the role of computers in the classroom of the next century is discussed.

Present and Future of Computers in Education

The impact of computers on education is twofold. The first impact is in using computers to support the actual teaching process directly (Blomeyer and Martin, 1991). The second impact comes through the application of computer networks in the educational process. The number of networks devoted to elementary and secondary schools has grown rapidly in recent years. A current list of K - 12 projects is available via anonymous FTP (File Transfer Protocol) from nyser.org, in the sub-directory CoSn/cni-draft-packet. The increase in the usage of computers as communication tools has also resulted in the development of the CBEHIGH discussion list (listserv@BLEKUL11.BITNET or listserv@CC.KULEVE.AC.NE) which focuses on issues related to computers as a tool in higher education.

The accessiblity and range of computer networks, both in subject content and the ability to transverse the globe (Updegrove, Muffo, Dunn, 1991; Mitchell and Paprzycki, 1991) has led many people to realize that computer networks constitute a new medium called cyberspace or virtual reality.

Knowing how to include networks, whether they are local networks that enable students to keep in contact with the professor or networks by which courses for credit at one university or college are taken by students at other localities, is just as critical as the more traditional usages of computers in the classroom (Paprzycki and Mitchell, 1992). To assess the computer backgrounds of prospective teachers, we decided to determine what were the current computer literacy requirements for teachers in the United States and how such requirements match their professional needs.

Computer Literacy Requirements for Teachers

In the period between January, 1992 and the present, computer network based discussion lists (AETS—Association for the Education of Teachers in Science; CNEDUC—Computer Networking Education Discussion; DEOS—Distance Education Online Symposium; DTS—

Dead Teachers Society; ERL—Educational Research List; CTI—Computers in Teaching Initiative; NEWEDUC—New Paradigms in Education List; IPCT—Interpersonal Computing and Technology) were used to ask two questions:

1) Is there a computer literacy requirement for prospective elementary and/or secondary teachers in your state?
2) If the answer to the above question is yes, how is that requirement met (through course completion,competency, etc.)?

A total of four mailings were made. The second, third, and fourth mailings contained a summary of earlier results with the request for additions and/or corrections. Thirty-six (36) replies were received.

While this is a relatively small number of replies, there is some validity to the data collected. First, the inquiries were sent to lists directly related to the topic. Thus, respondents could be considered "experts" in this area. Second, since there were multiple mailings and each subsequent mailing summarized the results obtained to that point, there would have been no need for a person from a state to respond if that state were represented. When there was more than one response from a specific state, it was to discuss requirements at individual schools. From this, we would expect the data gathered to be accurate.

The results of the investigations can be summarized as follows:

1) At least ten states (Alabama, Colorado, Massachusetts, Michigan, Minnesota, New York, Pennsylvania, Ohio, Virginia and Washington) do not have a computer literacy requirement for teachers.
2) Kentucky, Indiana, South Dakota and Texas do have specific computer literacy requirements. These requirements can be met by passing a
   a) standard programming course,
   b) course designed around the use of word processing, data base, and spreadsheet software,
   c) a course designed to evaluate, use, and incorporate education software into classroom use.

Several universities (Bowling Green State University, California State University - San Marcos, Colorado College, Miami (Ohio), Eastern Washington University, Memphis State University, Ohio State University, St. Thomas University, University of Alberta,University of Central Florida, University of Georgia, University of Iowa, University of Missouri - Columbia, University of Northern Iowa, Wright State University) have their own computer literacy requirements similar to point 2 above.

These results suggest that there are at least three different definitions for the term computer literacy. A person is considered computer literate if she/he:

1) is able to do simple computer programming;
2) is capable of using basic software packages;
3) can use computers as a tool in the workplace.

It is apparent that there are several factors which determine the definition for computer literacy. If the definition of computer literacy is accepted as the ability to use the computer in appropriate job settings (Gupta, 1992), then the results of this study indicate that many teachers are not computer literate. Results of the survey also show that very little consideration is given to teaching prospective teachers how to incorporate new technologies into the teaching process. Except on rare occasions, teachers are either not prepared to introduce computer usage in their future classrooms, or they receive a rather misguided preparation for doing so. One cannot expect a teacher to use Pascal (or any other standard programming language) to write his/her own software. It is also equally difficult to expect somebody only exposed to use of basic computer tools to be able to find a way to introduce them into the educational process.

When computers were first introduced, it may have been logical to expect people to utilize them by writing programs. However, because of how computers are now used and the rapid changes in computers since their introduction, this view should be discarded. Also, because of how computers are used, it may necessary to offer two different types of computer literacy courses. The first course would focus on basic skills, such as using word processing, database, and spreadsheet programs. The second would deal with skills needed for future work and would be dependent on the student's major and projected future employment.

A Computer Literacy Course For Teachers

As applied to the preparation of teachers, this second course would concentrate on all aspects of using the computer as a classroom tool. Such a course will be offered at St. Cloud State University during the Spring Quarter, 1993. It will consist of four parts: evaluating software, evaluating hardware, examining the use of authoring software, and using computer networks. See Appendix 1 for a copy of the course outline.

The first three parts of the course are in some sense repetitions of already established educational uses for computers. Educational software, like any software, can range from very good to very bad. It also ranges from simple drill-and-practice types to complex simulations. Students in the class will learn how to evaluate software, what criteria to use and how to apply such software in their classrooms. The second part will be primarily directed towards prospective secondary school teachers and upper level elementary teachers. Students will evaluate current hardware and design experiments where computers are used to gather experimental data. The third part of the course is based on the belief that if teachers are expected to do any programming then the level of authoring software is appropriate. It is the fourth part of the course that requires more discussion.

Computer Networks as a Part of Computer Literacy

There are a number of reasons for including network based communications into a computer literacy course for teachers. Computer networks can be used directly in the classroom to facilitate teaching (Paprzycki and Mitchell, 1992). Through the use of FTP, students and teachers can obtain public domain software, technical reports, and papers. Listservs can serve both as a means of communication between groups in a number of ways. The preparation of this paper and other recent papers by the same authors (Mitchell and Paprzycki, 1991; Paprzycki and Mitchell, 1992) was done virtually through the use of e-mail. The number of journals published only (or primarily) in an electronic form is constantly increasing—fully refereed PSYCOLOQUY, with an electronic readership of apporximately 20,000 and Post Modern Culture, reprinted by Oxford University Press, are examples of such journals.

As was indicated at the beginning of the paper, the use of electronic mail can also be used to facilitate research. When used interactively, computer networks can facilitate communication between students from different schools/localities/countries. This approach can then be used to support a variety of science projects (for a description of a project which can be adapted to computer communication, see Mitchell).

The globality of computer networks allows for the development of a multicultural approach. Recent changes in the world suggest that a teaching approach based solely on textbooks and limited to the physical classroom will quickly become outdated. Computer networks provide the classroom teacher with a means to provide his/her students with connections to this rapidly changing world. There are several projects oriented towards communication between individuals, both teachers and students, of various countries. Among these projects are KIDLINK, KIDCAFE, and Project IDEALS. Many countries also require that their students be computer literate (O'Lander, 1992). Therefore, by showing students how to use their computers as a communication tool, it would be possible to increase their multicultural awareness and, at the same time, reduce cultural differences (Ryan, 1992).

The Next Step in Education

The use of computer networks opens up several other possibilities which take education beyond the real classroom and create what can be called "virtual" classrooms. Computer based classes are not a new idea. A variety of courses, seminars and workshops are currently taught over computer networks. Combining together all of these offerings could lead to the creation of a virtual university (Palmer, 1992). Palmer has suggested that almost all functions of the university can be carried out over computer networks and suggested a possible *organizational form for such a school. It should also be* noted that Palmer is carrying out much of his discussion via another electronic journal, Thinknet.

While his disussion is purely theoretical, Jyrki Kuoppala from Helsinki University of Technology is attempting to create the Usenet University. This "society of people interested in learning, teaching and tutoring" will operate in cyberspace and be facilitated by usenet-type communications (Kuoppala, 1992). While there may be some resistance to this approach, there must be some consideration given to such unorthodox educational approaches if education is to teach all individuals in tomorrow's society.

Conclusion

It is a given fact that today's society is becoming increasingly computer oriented and that individuals need to be computer literate. It may be argued that teaching will always require a personal touch and that touch can only be arrived at by the physical presence of the teacher in the classroom with the student. However, the changing nature of both society and the learner along with the rapid growth of knowledge suggest that alternatives to traditional teaching need to be considered.

If schools of tomorrow are expected to prepare graduates of those schools to use available technologies, then teachers need to be prepared to be responsible for that education. Such preparation must include all facets of the computer as a tool. This includes the use of computer networks as well. It is our belief that, even though this is not the only possible solution, the course we are developing is a step towards addressing the needs of society.

Appendix 1

Course Outline
SCI 466 "Computer Applications in Science Education"

1. Course content
   a. Computer based communications
      i. Using main-frame computers to communicate
         (1) E-mail
         (2) Listservs
         (3) Conferencing
      ii. Transferring files
         (1) Obtaining public domain information
         (2) Ethics of using public domain information
      iii. Activities
         (1) Personalize an e-mail message
         (2) Send an e-mail message to someone on campus; send an e-mail message at a second location (off-campus).
         (3) Obtain a list of lists from the VAX at NDSU.
         (4) Subscribe to a listserv of own choice.
         (5) Obtain a document from another location via anonymous ftp.

   b. Evaluating software
      i. Types of software
         (1) Tutorial
         (2) Guided simulation
         (3) Exploratory
         (4) Cognitive tool
      ii. Evaluation guidelines
         (1) Use of graphics
         (2) Motivation of learner
         (3) User interface
         (4) Feedback
      iii. Activities
         (1) Using identified guidelines, evaluate selected software for each type of computer system available (Apple, MacIntosh, and IBM).
         (2) Prepare lesson plans showing how to use each type of software in a classroom setting.

   c. Evaluating hardware
      i. Activities
         (1) Using identified guidelines, evaluate selected hardware for each type of computer system available (Apple, MacIntosh, and IBM).
         (2) Prepare lesson plans showing how to use each type of hardware in a classroom setting.

   d. Evaluating/using authoring programs
      i. Activities
         (1) Prepare lesson plans showing how to using an authoring program in a classroom setting.

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A novel database lesson for preservice and inservice secondary teachers

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Foreword

In California, state credential requirements now include a mandate that all teachers seeking a clear teaching credential demonstrate competency in "Educational Computing and related technologies" (Murdock & Desberg, 1992, p. xi). This mandate was intended by the state legislature to go beyond computer literacy and to integrate the computer thoroughly into the curriculum. In order to address this legislation, faculty members who have been involved in teaching technology within the 20 California State University campuses collaborated to produce a manual, *Computers in the Curriculum: Exercises for Integrating Technology into Instruction* (Murdock & Desberg, 1992), for use in computer education classes. The following article is drawn from this manual; it provides a useful application for a database that will motivate teachers to integrate the computer into the secondary English curriculum.

Introduction: Why Create a Database?

According to the Ford Foundation, an estimated 60 million Americans are at least functionally illiterate (Kozol, 1985). In discussing these dismal statistics, Atwell (1987) comments that

> Teachers of English can't help but be concerned. The level of literacy defined as 'functional' becomes increasingly more sophisticated, yet in spite of all of our heartfelt, explicit messages, the activities we sponsor and demonstrations we provide are creating too many non-readers - students who either cannot or do not read" (p.153).

The importance of motivating students to read is unquestionable and it is certainly the English teacher's most profound task. In secondary classrooms across the curriculum, more teachers are now recognizing the value of literature in stimulating students to read within other content areas as well as English. The recently implemented *California History/Social Science Framework*, for example, is literature-based. Science teachers are also beginning to take responsibility for teaching reading and writing, as they acknowledge their use in motivating students to study biology, physics, and so on. Secondary schools throughout the state of California have implemented Sustained Silent Reading (SSR) as a *whole* school activity during home room. The relationship between reading and writing competence as well as increased language skills such as vocabulary acquisition has been established(Irvin, 1990).

While much attention has been paid to the psychological and linguistic aspects of literacy by learning theorists, it is only recently that the social aspects of reading and writing have been taken into consideration. Comprehension is enhanced through communication with others regarding what has been read (or written) (Nystrand &

Himley, 1984). As adolescents develop, "Their intense interest in themselves, their social interactions, their emotional ups and downs, and their new capacity for analytical thought can be used to help them become more literate." (Irvin, 1990, p. 6). Cooperative learning group strategies can therefore facilitate student interaction and create excitement about what has been read, through discussion and preparation of critiques to share with the rest of the class.

The proliferation of computers in the schools is good news for the secondary classroom. In addition to the growth of Computer Assisted Instruction (CAI), teachers have begun to think creatively in using tools such as word processors and databases with their students. English teachers, Social Studies teachers, and any others who wish to motivate their students to read good literature can do so by forming a class literature database. Students, either working individually or in cooperative learning groups, read novels (or non-fiction), and as they complete their work, instead of (or in addition to) writing book reports, enter their books into the class database. Cooperative groups may work together by reading the same book, by reading works on the same subject or novels on a given theme, or by reading novels by the same author. Coming up with follow-up activities for their books can be a creative group project that requires a high level of cognitive thinking.

The students need to be taught both to create and to use databases, although at first they may use pre-existing fields. Eventually, as the database fills up with entries, students will be able to use the database to find books that they may want to read, within a given *genre* or by a given author, with an ultra-high rating by other students their own age, or some combination of the above.

Lesson Overview

The purpose of the following exercise is to assist preservice and/or in-service secondary English teachers, as well as those in related fields, in helping their students to develop a literature database to use in their classrooms. Teacher educators involved in computer education courses can use this lesson to demonstrate a way to integrate the database into the secondary classroom.

The teachers will be able to input and manipulate data that should prove useful to them in working with their own students, as well as reinforce many of the rudimentary database skills. During the exercise, they will have the opportunity to first create and then merge *their* literature databases with those of several other students in a small group, in order to share their efforts and so that they will have cooperative learning techniques modeled for them.

The latter part of the exercise will require them to manipulate data within the larger database. In addition, it is hoped that they will come up with their own ideas regarding extending the fields listed, clarifying their definitions, and creating new ways to integrate the database into their classrooms.

Lesson Objectives

The following skills will be developed or enhanced in this lesson:

- Collecting data about records & deciding on database fields.
- Inserting & deleting database fields.
- Changing column widths.
- Merging several small database files into a single file.
- Sorting and answering questions that arise from data in a single field.
- Changing field positions.
- Responding to questions about connections between data in two or more fields.
- Concealing and revealing fields
- Creating and editing database report formats.
- Using report selection rules and sorting.
- Previewing database reports on the screen.
- Printing database reports.

Lesson

Collecting Data About Records

In creating a database file, it is important to first decide what information you think it should describe; *i.e.*, what questions you think need to be answered. Your purposes and audience need to be considered. English teachers and others who would like to encourage reading and stimulate student interaction regarding books, might pool their ideas about what questions they and their students would like answered regarding book evaluations.

Deciding on Fields

Once the above has taken place, fields that address your questions and are appropriate to your audience need to be enumerated and clarified. In the literature database, since the audience is secondary school students, and the purpose is to motivate students to read, as well as to promote dialogue and thus comprehension of the literature, the following fields are proposed:

- Title. Name of novel or work of non-fiction.
- Author(s). First and last names of all authors. Last name comes first.
- Copyright Date.
- Publisher. So that others may find the book easily.
- Fiction/Non-fiction. Put an "F" for fiction or an "NF" for non-fiction.
- Genre. Categories include:

1. *Non-fiction* - biography, autobiography, history, philosophical essay, literary essay; and
2. *Fiction* - adventure, science fiction, fantasy, romance,

spy, horror, mystery, sports, animal, historical novel.

- Theme/Thesis. Includes:

1. *Non-fiction* - author's thesis or purpose for writing (if any); and
2. *Fiction* - theme expressed in a few words, *e.g.*, man against nature, boy meets girl from wrong side of tracks, fish out of water.

- Setting. (If appropriate) Includes: place, time, feeling.
- Major Characters/Figures. Describe no more than a few.
- Rating. Rate on a 1 to 10 scale, with 10 being best.
- Critique. Explain the rating, commenting on plot, style, and so forth. Limit to no more than two or three sentences. Examples: "Because it was written from the point of view of [one major character], I really got to know what he was like," or "It had an interesting descriptive style."
- Follow-up activities. List and describe in a few words; for example, a follow-up to reading *Tom Jones* might consist of something like the following: "Pretend you are a newspaper reporter in the eighteenth-century England of the book and write an in-depth interview article with Tom after he has embarked on his adventure."
- Reviewer. Name of student reviewing book, last name first.

Teachers must instruct their students on the applications of the above-mentioned fields, and must clarify for them such items as what a "10" on the rating scale actually means.

Forming the Database using Microsoft Works for the Macintosh

The sections below provide step-by-step instructions on how to set up the literature database using Microsoft Works 2.0 for the Macintosh. Basic knowledge of the database management components is assumed. Similarly detailed instructions for both the Works program for IBM compatibles and the AppleWorks program for the Apple IIe are contained in Mach (1992). Be sure your trainees understand the basic steps of database management before proceeding.

Inserting and Deleting Data Base Fields

Step 1. Start the Microsoft Works program and select the database option by clicking on the DATABASE Icon and selecting "new." A new, blank database will be opened and a dialog box will appear prompting you to enter a name for the field.

Step 2. Begin inputting your field names by deleting "Untitled1," and typing in "TITLE." Then click on "Add Field." Continue this process until you have entered all the field names from the list below. To save space, you can abbreviate the names using the titles in parentheses.

- TITLE
- AUTHOR
- Copyright Date (CDATE)
- Publisher (PUB)
- Fiction/Non-Fiction (FICTION)
- GENRE
- Theme/Thesis (THEME)
- Setting (SET)
- Major characters/figures (CHAR)
- Rating (RATE)
- Critique (CRIT)
- Follow-up activities (FOLLOW)
- Reviewer (REV)

Later, for your own use, you may add to, delete, or change the fields, in order to accommodate your own students' needs. Since you will be doing this after your records have been entered, you will need to use the pull-down EDIT menu to rename, add or delete fields.

Changing Column Widths and Field Positions

Step 3. Before entering your records, you may lengthen or shorten your field column widths by placing the cursor at the end of the rectangle following each field name until your cursor becomes a two-way arrow. Click on the mouse and hold while you drag your columns to the right to widen or the left to shorten the rectangles. Do this now so that you will have room to enter your records.

Step 4. You may also move whole fields around the screen to reposition them. Click on the beginning of the field name, AUTHOR, until you see the hand. Hold and drag the entire rectangle wherever you prefer. Now move it back into its original position. You may do this at any point in the creation of your file.

Inserting and Deleting Records

Step 5. Click on the rectangle immediately following TITLE. Begin entering your records. Use books that you think would be of interest to your students. After all, this is going to be a useful database! You should have at least 10 records before you finish. When you are done, pull down the FORMAT menu and put your cursor on "Show List" so that you may get into the multiple record layout.

Step 6. In order to insert records after you have already entered your data, place your cursor on the record immediately following the place where the insertion is to go and pull down the EDIT menu. Select "Insert Record" from the menu. You will now have a blank record before the selected record. If you were to enter information, you would go back to the "form window" and pull down the FORMAT menu. Don't bother doing this now-unless you really need to!

Step 7. Deleting records is done in a similar manner. This time place your cursor at the beginning of the blank record while you are in the multiple record format. Click and drag the mouse so that you highlight the entire record. Pull down the EDIT menu and select "Cut" from it.

Changing Column Widths & Arranging Fields in the Multiple Record ("List") Layout

Step 8. With your data in the "list" mode, you will notice that some of the columns may still be too narrow or too wide for the information contained, and you will no doubt wish to change column widths. Position the cursor on the right edge of the field name box you wish to alter and, once again, it turns into the two-way arrow. Click on the mouse and drag the arrow to the right in order to widen the column and to the left in order to shorten it.

Changing Field Positions

Step 9. You may also wish to rearrange the order in which the fields are displayed. In order to change field position, place the cursor on the field you wish to move. The cursor becomes a hand; click on the mouse and drag the field either to the right or to the left and into the position you prefer. Any field name you pass over will be highlighted. Release the mouse button when you are adjacent to the appropriate field. If you are dragging left, the field you are moving is inserted to the left of the highlighted field, but if you are dragging right, it is inserted to its right.

Changing the Format of a Field

Step 10. You may change the way a field is set up by first clicking on that field or entry in the field, then pulling down the FORMAT menu and clicking on "Set Field Attributes." The "Set Field Attributes" dialog box appears.

Step 11. For field columns that contain numerical information, you need to click on "numeric" for type, "fixed," for display, and whatever alignment and style you prefer. For textual information, select "text" for type, "general" for display, and so on.

Step 12. When you are finished formatting your field columns, pull down the FILE menu and click the mouse on the "Save as..." selection before going on to the next step. Name your file "LIT" followed by your own initials. Click "save" so you can save to a data disk.

Merging Several Small Data Base Files into a Single File

Step 13. Now that you have created your own literature data base file with at least 10 records, it would be extremely helpful to enlarge the file by adding several other data base files to it. Get together with those in your cooperative group if you have one, and if not, find at least three other people for this activity. Make sure you all have the same fields in the same order. If not, then change them to conform to one format.

Step 14. Next, using one of your data disks, change the name of one of your files to LITGRP#, using the "Save as..." selection from the FILE menu.

(Steps 15 through 17 should be followed for each of the data disks.)

Step 15. In order to move records from all the LIT files into the LITGRP# file, you will be using the "copy" command from the EDIT menu. For each of the remaining data disks, open each LIT[initials] file and with this file in multiple record (or "list") format, pull down the EDIT menu and click on "select all." Then click on "copy."

Step 16. Close the LIT file by pulling down the FILE menu and clicking on "close."

Step 17. Open the LITGRP# file and pull down the EDIT menu. Click on "select all," and then click on "paste."

Step 18. Insert the next data disk and follow steps 15 through 17 again.

Step 19. When this is complete, you should have merged all the smaller database files into one.

Step 20. Inserting each disk separately, pull down the FILE menu and click on "save" so that each person in the group may have a copy of LITGRP#, the enlarged database file. You will be using this larger file to complete the remainder of this exercise. In your own classrooms, you may continue to build your literature database in this fashion, although you certainly will not expect each of your students to come up with 10 records at once! Members of cooperative learning groups in the high school classroom may merge individual records into one group file; then the class may merge all group files into one "class file."

Sorting and Answering Questions that Depend on a Single Data Field

Step 21. Now, working individually, make sure you retrieve the LITGRP# file on the screen. You might now be interested in ordering your records so that you can search for specific titles to make sure they are in your database, and to make sure you have no duplicates. In order to sort your records alphabetically, move your cursor to the "TITLE" field name and click the mouse. Pull down the ORGANIZE menu and click on "sort." Click on the "From A to Z" selection.

Step 22. You may now move through the file by scrolling with the UP and DOWN ARROW keys or by using the mouse and clicking on the arrows to the right of the screen.

Step 23. It might also be interesting to find out what has been included for different authors, so you might choose to rearrange the file by author's name. Switch the cursor to the field, AUTHOR, and click on the field name. Pull down the ORGANIZE menu and click on "sort."

Click on the "From A to Z" selection. You are now able to view the works by author.

Step 24. Switch field positions as in step 9, so that AUTHOR is your first field.

Responding to Questions about Connections between Data in Two or More Fields

Step 25. In sorting by different fields, you may be able to pose a number of interesting questions. For example, after sorting by author, you might ask:

- In what genre does Ray Bradbury tend to write?
- What kinds of themes seem to recur in his novels?

Similarly, in sorting by "Theme" the following might be appropriate:

- Which authors choose to write about "Man vs. Nature?"

In sorting by "Rating" think about these questions:

- Who are the most popular authors in this class? Among boys? Among girls? (To facilitate this, you might add "Gender of Reviewer" as a field.)
- What does this tell you about their preferences in genres and/or themes?

Try coming up with at least two more questions such as these that you would use with your own students.

Concealing and Revealing Fields

In answering questions such as those posed above, it is not necessary to view all the fields in the database, nor is it possible. To make the task at hand easier, it is possible to conceal as many fields as desired. For example, in the third question posed above, only the fields of AUTHOR and THEME are necessary.

Step 26. As delineated in step 9, move the fields, AUTHOR and THEME all the way to the left. Widen the fields that are particularly interesting to you so that unwanted fields are no longer visible on screen.

Step 27. Arrange your database file alphabetically by author, as described in Step 23. It is now possible to see which themes were favored by which authors.

Step 28. Before going on, we'll return the fields to their original widths and rearrange the report by TITLE. Move this field back to its original position, all the way to the left, and alphabetize by TITLE.

Creating and Editing Database Report Formats

In the literature database, a student may want to search for novels on a given theme, or novels on a given theme that were written by a particular author and that have a student rating of "8" or better. Following is one function that enables such a search. It will also allow you to print certain select information from the database document.

Step 28. When you pull down the REPORT menu you will need to click on "New Report" if you do not already have one on file. Do this now.

Step 29. Pull down the EDIT menu and click on "Change Report Title." Press DELETE to erase the automatic report title and give the report the title "Best SciFi." Click on "O.K."

Step 30. Pull down the ORGANIZE menu and click on "Record Selection." A dialog box will now appear so that you may define the parameters of your report.

Using Report Selection Rules and Sorting

Here, again, it is important to consider what questions you actually want answered from the database. In the literature database, LITGRP#, suppose you would like all to see all the novels that are science fiction and that are rated "8" or higher by students. If no one in your group entered any data on a science fiction novel, then choose some other genre that is more popular within your group.

Step 31. Before starting, since you will be sorting this report by author, so you need to click on the field name, AUTHOR, pull down the ORGANIZE menu, click on "sort," and select "From A to Z."

Step 32. In order to search for the information to be included, you must define what is needed. Highlight GENRE using the mouse to move your cursor and clicking on it. You may have to scroll to see all the fields.

Step 33. In the box at right are several comparison phrases. You may again scroll to see all the phrases. Highlight "equals" by clicking on it and type the comparison information, "Science Fiction," in the space provided.

Step 34. Click "Install Rule." You should now have a blank in the "Record Comparison Information" box.

Step 35. You will now be given a choice of several connectors. Click the button next to "and."

Step 36. Now highlight RATE and click the mouse.

Step 37. Select "is greater than." Input "7" in the "Record Comparison Information" box.

Step 38. Click on "install rule."

Step 39. Click on "select." Works immediately chooses those records that you have specified.

Step 40. Since you now have the report organized by author, it would be a good idea to change field positions. Click on the field name, AUTHOR, and then place the cursor on the left side of the column until you see the double arrow. Drag the field all the way to the left. Lengthen or shorten columns in order to be able to fit in the most information. Works allows you to print your database file with an 11" width and 8 1/2" height.

Step 41. You may eliminate the grid by pulling down the FORMAT menu and clicking on "Show Grid." Do this now. The lines should disappear.

Step 42. Saving at this point will save the report format as well as the database file, so pull down the FILE menu and click on "save" to make sure you do so.

Previewing Database Reports on the Screen

Once you have the format you would like, you may preview the report on the screen.

Step 43. Pull down the FILE menu and click on "Page Setup." Because of the amount of information to be included, it would be preferable to print lengthwise, so click on the lengthwise "Orientation."

Step 44. If you would like a header or footer, this is the place to select it. Works will automatically number pages if you give the command "&P" and it will center the header or footer with the command "&C." Under footer, input "&C&P" now. Click on the "O.K." box.

Step 45. Pull down the FILE menu again and click on "Print." The Print Dialog Box should appear. Click on the box next to "Print Preview" and then click on the button that is labeled "Print." Works prints to the screen a minute page by page replica of your document. When page 1 appears, move the cursor to the page and it becomes a magnifying glass. Click on it in a particular place and the document is enlarged so that it is readable. You may continue to view the database report in this way by clicking on "next" for the next page, and so on. At this point you may need to go back and edit your report further, as you may have cut off some vital information, or you may decide you don't need information that has been included.

Printing Database Reports

Step 46. Once you are satisfied with the format of your report, print out a hard copy by clicking on "Print" (if you are still in the "Print Preview" mode), or by pulling down the FILE menu and clicking on "Print." Click the "Print Preview" box again to erase the "x" and click on the button marked "O.K."

Conclusion

The lesson outlined above is available in greater detail in "Using a Literature Database in the Secondary Classroom" (Mach, 1992), where step-by-step instructions for MicroSoft Works for the IBM and Appleworks for the Apple II are included. Teacher educators involved in computer education courses should find this lesson useful in demonstrating to their students ways to integrate computers into the secondary classroom.

By design, the number of fields presented is large and may seem a bit overwhelming for secondary students. Teachers may select from the array whatever fields they feel may be useful.

If time available to teach the basic database skills necessary is a problem, cooperative learning may prove a helpful strategy. Many secondary students already are computer literate, and these students could be dispersed among groups to assist the other students in these basic skills.

Finally, it is hoped that the lesson will be a catalyst to teachers in creating new ways to use the database in the classroom. For example, a different kind of literature database could be used to analyze a given character in a novel. Fields could include "what s/he says," (and where), "the way it is said," "what s/he does," (and where), "what others say about her/him," and so on. The author appreciates any further suggestions regarding related uses of the database in the English classroom.

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Establishing a new course: Design and presentation of information

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Technology available in today's world can help educators make a difference for their students in two ways—by using the technology to prepare and deliver their presentations and by including in the curriculum the skills needed to organize, prepare, and deliver effective presentations using new technological developments. Visual presentation design is actually an old topic with fantastic new possibilities—due to current technological developments. Since most people tend to teach as they were taught, they may not be aware of or take advantage of the new instructional tools and methods available today.

The Need for Effective Presentations

In the days of Socrates, before books were available, teachers were dispensers of information. In fact, Socrates was fearful that a new invention, books, would cause forgetfulness in the minds of people. Today the role of educators becomes one of a facilitator and a motivator. Books provide the information, while the classroom promotes a learning environment. The instructor provides the structure by issuing assignments, answering questions, and giving tests.

Since research concludes that both seeing and hearing are important to learning and retaining information, another role of the instructor is to provide alternate methods of learning to reading. Both learning and retaining are greatly increased if information is both seen and heard.

Therefore, instructors need to enhance the learning process by making effective oral presentations in addition to their role of making assignments and giving tests. High technology is providing the tools to make these presentations more effective. Interactive multimedia programs are also available to enhance the learning process.

The Value of Visual Images in Presentations

According to Suzanne Bailey, an organization and management consultant in Vacaville, California, 70 to 80 percent of the American public have a preference for visual learning. She believes that using graphics in agendas, minutes, and other group work is not just decoration but has significant purpose (3M Meeting Management Institute, September, 1992, p. 3).

Douglas Vogel (Meeting Management News, September, 1992, p. 1), a leading academic researcher known for his pioneering work in the use of groupware and other computer-based presentation systems, identifies which high technology tools enhance audience comprehension and retention, and which actually reduce effectiveness. According to Vogel, audiences respond best to speakers who use technology as a presentation aid. Response declines rapidly, however, when the speaker takes a back seat to complex on-screen visuals that appear "canned" to the audience.

Key points in the research report show that presenters can improve the audience's perception of their presentation with:

- Simple computer-generated graphics (bullet charts, bar or pie charts, etc.). These simple graphics, whether displayed with an overhead projector or on a projection panel or monitor, boosted the audience's perception of the speaker as well as its comprehension and retention-so long as the chart conveyed relevant data. Not surprisingly, artwork added to presentations with little linkage to the topic being presented detracted from the audience's understanding of the presentations.
- Animation. A glitzy multimedia presentation will not help an unprepared speaker impress his or her audience, but a good speaker can use animation very effectively to boost audience retention. The most effective animations proved to be among the simplest, such as bar charts that grow or text revealed line by line.
- Graphic transitions. Using just transitions (such as wipes, fades, etc.) between graphics detracted significantly from the audience's perception and retention. However, when consistent transitions (using the same transition effect between each image) were combined with animation, audiences responded much better than they did to transitions alone and slightly better than they did to animation alone.

Research Findings of Visuals in Presentations

Much research has been done that demonstrates how visuals used in presentations can make a difference in how people absorb information. A few of the studies that validate the effectiveness of using visuals include:

- Green (1984) quoted the following findings supporting the use of audio-visual presentations. Physiologically, 83 percent of all learning begins through the eyes. The Armed Forces have proven that people retain facts up to 55 percent longer when they learn by a combination of sight and sound.
- Colthran (1989) cited two additional studies that prove the value of visuals. At the University of Wisconsin, researchers determined that learning improved up to 200 percent when visual aids were used in teaching vocabulary. Studies at Harvard and Columbia found audio-visuals improved retention from 14 to 38 percent over presentations where no visuals were used.
- Kupsh (1975) proved the effectiveness of using synchronized sound-slide packages in teaching beginning typing. The experimental study showed that the use of five packages, each ten minutes or less in length, increased the knowledge of basic typing fundamentals during a semester course of beginning typing. In addition, students using the sound-slide packages reacted more favorably toward the class in an opinionnaire inventory.
- A study by the Wharton Applied Research Center of the Wharton School of Business showed that a simple overhead projector could significantly influence the outcome of a business meeting. Projector use reduced the length of the meeting by nearly one-third and also sparked a larger percentage of participants (nearly two-thirds) to make immediate decisions after the meeting (Oppenheim, 1981).
- The same Wharton Study also found that presenters who used overhead projectors were rated more favorably overall (Oppenheim, 1981).
- Additional research at the University of Minnesota also found several interesting facts concerning how the use of visuals enhance a speaker's image: (1) The use of overhead transparencies results in the presenter being perceived as more interesting but less professional than a presenter using 35 mm slides. (2) Effectiveness varied as a function of speaker quality. A "typical" speaker using presentation support has nothing to lose and can be as effective as the more proficient speaker who has used no visuals. The better the speaker is, the greater the need to use high-quality visual aids (Vogel, Dickson, Lehman, Shuart, 1986).
- A 3M Meeting Management Institute questionnaire surveyed 1,000 Successful Meetings Magazine subscribers. Of the 585 respondents, 96 percent felt that audio-visual aids were "very effective" or "reasonably effective" in advancing a presentation's or speaker's objectives. The majority of respondents (63 percent) felt that the presenters could use more training in the use of audio-visual support tools(Lewis &Clark Associates, 1990).

Market Size and Growth Projections

The market for presentation software and large-screen presentations devices is presently fairly high, and projections indicate a significant growth increase. New Media Research of Los Altos, California, a leading presentation market analysis firm predicts that the world-wide market for presentation software will rise from a $472-million market in 1991 to a $498-million niche in 1992, swelling to a $677-million market by 1995. They also forecast that the market for all types of large-screen presentation devices will climb from $742 million in 1991 to $866 million in 1992, and reach the $1 billion mark by 1995 (Todd, 1992).

The Need for a Course

In the business world, the terminology is to "make a presentation." Unfortunately in academia, the archaic term of "read a paper" is still being used. Awards at professional conferences are made for the best research or the best paper-not the best presentation.

Teachers seem to be aware of the need for training students in making presentations as they frequently require students to make presentations in a variety of courses-particularly in upper-division course work and on the graduate level. However, they most likely do not have the time to give proper instruction in how to create effective presentations. Students who are required to take one or more courses in communications as a part of their general core often choose courses in group discussion. Even those who enroll in a public speaking course are probably going to find that the course consists of studies more related to becoming an orator than in making a presentation.

Students enrolled in business communications may be required to make a presentation as a part of the course but also receive very little "how-to" preparation. Seventeen business communication textbooks, published by well-known authors and publishers and used extensively across the United States, were analyzed in a study by Dr. Pat R. Graves, a professor at Eastern Illinois University. A breakdown analysis showed that the majority of the time was spent on business writing, with only an average of 4.31 percent of the total material addressed the subject of presentations (Graves, 1992).

The inclusion of a course on the design and presentation of information is truly an interdisciplinary study and may be located in a variety of departments such as business, engineering, science, art, and teacher education.

Suggested Course Content

The content of a course on presentation design is really a computer, speech, art, and educational technology course all rolled into one. A suggested topic outline includes:

Creating Effective Presentations
Planning the Strategy
Selecting the Media
Developing the Message
Using Diagrams and Graphs
Designing Visuals
Working with Color
Considering the Environment
Being a First-Rate Presenter
Conducting Meetings
Delivering and Evaluating
Moving Into Multimedia

Many desktop presentation software packages are available in DOS/Windows and Mac platforms. For the most part, the application packages all have similar features and capabilities. Therefore, any one can be chosen for the class to use. A teacher may select a desktop presentation application program (or even two or three) to have available in the classroom, or allow the students to use whatever type they have access to at home or work. Both word processing and desktop publication software can be used in preparing visuals, but desktop presentation software simplifies the task and has many added benefits.

The course should not become a course devoted only to teaching a specific software package. The function of the course is the design and presentation of information, and the software application is a tool used in the process.

An effective way to teach such a course is to have each student meet the challenge of designing and implementing presentations as opposed to simply giving them an outline of the steps to take. Following are suggested projects which night be included in a program.

Project 1: Introductions

A simple project that acquaints the students with platform skills and correct use of the overhead projector is to have each class member make a personal introduction. The following steps describe the procedure:

- Make an overhead transparency using your own name as the heading a bullet listing of information about yourself-each bullet item should have only one or two words.
- Demonstrate the correct way to use an overhead: (1) place a frame on the platform so that light does not glare around the edges and (2) avoid having the light on unless a transparency is on the exposure table. .
- Serve as a model by using your transparency to introduce yourself to the class.
- Give each student an overhead transparency and marker. Have students write their name across the top and make a bullet list with three points to include in their self introduction.
- Encourage students to use graphic images or marks to create interest.
- Allow each student one or two minutes to do a personal introduction in front of the class using the transparency as a prompt.

The goals of this project are many. (1) The assignment provides a means of letting students get acquainted. (2) Students learn the use of a simple bullet chart. (3) Students are instructed in the proper use of the overhead projector. (4) Students are given an opportunity to plan and organize their thoughts. (5) Students experience using visuals aids as notes and become less conscious of speaking front of a group. The time required for planning and preparing the visual is approximately 30 minutes for a class of 20 to 25 students. This time is well spent as it serves to break the ice and get students acquainted as well as getting them up front fast for a first presentation.

Project 2: Group Design

After basic learning of software is completed and general design concepts have been presented, a group design project is a logical next assignment.

- Choose a topic of general interest-such as computer software ethics, designing a home office, cellular telephones, international business, value of college education, importance of meetings, etc.
- Find one or two short magazine articles on the chosen topic and duplicate for the class members. Make sure the information provides information for bullet chart, statistics for a graph, etc.
- Let students divide into groups of three, four, or five making sure, if possible, that a strong, experienced student is in each group. As a group, they are to plan and design ten visuals. Students can individually read and storyboard their ideas outside of class before meeting as a group to combine their ideas for the ten visuals.
- Allow time for the keyboarding of the ten visuals. Actually, one or two students will need to take the leadership on this activity, but the others can learn by observation.
- Have each group select a member from their group to show and the ten visuals. Do not have them actually deliver the presentation but talk about how and why the visuals were made.

A group design project provides a good starting point for students. More advanced students will take the leadership and provide help and encouragement to others.

Project 3: Videotape Feedback

Videotaping a short presentation of two to five minutes can be most helpful. If facilities for videotaping are available, students can make their videotaped presentations individually or within a small group. Then, the videotape can be played back for the entire group to critique. Students should be given the opportunity to watch their own presentations numerous times and complete a self-evaluation indicating goals for improvement.

Project 4: Research Presentation

A research presentation is assigned on a subject pertaining to the class-such as competence in speaking, importance of visuals, meetings, use of color, film recorders, scanners, clip art, fonts, etc. Depending upon the size of the class, the research presentation can be 10 to 15 minutes long. Since individual presentations do take large portions of class time, these presentations serve as a valuable learning tool. Each presenter learns more about one topic; the whole class has an opportunity to share in this learning.

Project 5: Final Presentation

A final presentation assignment is on a topic of choice for each student. The choice can be on a topic needed for work, another class, or a subject of interest to the student. Letting students choose a topic of interest or need makes the assignment more worthwhile for students. Consequently, they are likely to become more involved and are willing to spend extra time on this assignment. The final presentation should be 15 to 20 minutes if classroom time allows.

Evaluations on Projects 3, 4, and 5 from an instructor are important, but peer evaluations are extremely helpful. Students are liable to really listen and take heed if numerous students make similar comments to yours. Actually, students may be more critical than you are in your evaluation. A form can be provided to channel these critiques.

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AIMS CoPlanner: Computer technology supporting collaborative decision-making across the curriculum

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Computer technology has the potential to transform educational structure and process in ways which remain largely unexplored. Most educators have not yet embraced this technology nor have they investigated the possibilities it affords them to contemplate new ways of viewing their daily instructional actions and interactions. Certainly, one of the significant challenges faced by teacher educators today is to prepare preservice teachers adequately to use the microcomputer in new ways in their subsequent teaching careers (Valdez, 1986). Computers are common equipment in the schools; however, unless teachers are prepared to use them as an integral part of their teaching, this important technology may be given a marginal position on the fringes of the school curriculum (White, 1990). The best way to assure that computers will become practical tools for the teacher is to integrate their use into the core of preservice preparation programs (Norvak & Berger, 1991; Troutman & White, 1991). Using computers in preservice teacher education courses and ensuring that our teachers-in-training use the technology during their university practica are essential (Troutman & White,1991).

A few years ago special education faculty at the University of Saskatchewan were facing a two-fold challenge: to integrate the use of computer technology into the resource teacher preparation program and to change the practicum experiences from a clinical to a school base. In striving to address both challenges, faculty developed and are now field testing AIMS CoPlanner, a software application designed to support the collaborative roles of educators who share instructional responsibility for learners with special education needs.

AIMS is an acronym for Assessment, Instruction, and Management Support, the main purposes of the software, while "CoPlanner" implies that the software is intended to facilitate teachers and support staff in collaborative planning for students with special needs. The general purpose of CoPlanner is to support all of the assessment, program planning, teaching, monitoring, and reporting tasks of teachers and other educators, while leaving educational decisions in the hands of the professionals. The primary objective of this paper is to describe and illustrate the conceptual and practical attributes of AIMS CoPlanner, while a secondary purpose is to describe the Saskatchewan special education context within which CoPlanner was developed.

A Saskatchewan Context for CoPlanner

Faculty in the Department for the Education of Exceptional Children at the University of Saskatchewan have been involved in the preservice preparation of resource teachers for more than twenty years. At approximately five year intervals, they have done surveys of their past graduates, asking how well prepared they were for their jobs and what they would like to see improved in the resource teacher education program. In the last two surveys, resource teachers gave high priority to including more instruction on the use of computer technology in required coursework and on making the practicum experiences school-based, rather than clinically-based.

In the wider provincial education context, many of the paradigm shifts in special education service delivery documented elsewhere in North America (Skrtic, 1991; Stainback & Stainback, 1984) were also affecting us. During the 1980s, for example, remarkable progress was made toward integrating students with special needs into regular classrooms in the community schools (Sanche & Dahl, 1991). Program planning and service delivery for these students with special needs became the responsibility of teams of professionals (Friend & Cook, 1992; Idol, Paolucci-Whitcomb, & Nevin, 1986). Indeed, the "teams" approach has spread to many school districts in Saskatchewan and collaborative service delivery has emerged as the current instructional practice paradigm for special educators. The shift has meant a major change in the ways that resource teachers and other support personnel work. Resource teachers and other special educators now place greater value on the interpersonal skills which allow them to communicate effectively, to plan instruction jointly, and to collaborate in various phases of the delivery of shared instruction in the classroom.

As integration and mainstreaming of students with special needs have gained momentum (Sanche & Dahl, 1991), the curriculum offered in the classroom has become a matter of greater concern for all students. In Saskatchewan, a core curriculum has been adopted for schools throughout the province (Saskatchewan Education, 1988) with suggested adaptations for students with special needs encouraged at all levels (Saskatchewan Education, 1992). When a student with special education needs is integrated into the regular classroom, there is an expectation that the student will be following the same curriculum,with appropriate adaptations, as do the other students in the classroom. When several different educators share responsibility for instructional planning, and for the many important details involved in joint curricular planning, computer technology can be used effectively across the curriculum. AIMS CoPlanner was developed specifically as a computer model of the collaborative decision-making role of the resource teacher— a model which can be used initially to teach about the role of the resource teacher and subsequently as a tool to support the actual work of these teachers.

The Conceptual Bases of CoPlanner

While microcomputers have become common technology in the schools, they are most often used for computer assisted instruction (CAI) rather than as support for the instructional planning tasks of the teacher (Lillie, Hannum, & Stuck, 1989). Baker (1978) maintained that computer managed instruction (CMI) could potentially contribute more to positive educational outcomes in the schools than almost any other use of the computer. Nevertheless, if the proportion of the published literature devoted to CAI can be taken as an index of computer use, most teachers are using the computer for CAI (Kulik, Bangert, & Williams, 1983; Woodward & Gersten, 1992). According to the classification system provided by Lillie, Hannum, and Stuck (1989), existing CMI programs tend to be "integrated learning systems" or "subject-specific instructional management systems", both relatively "closed" systems in which instruction is focused on a single curriculum or subject. Both systems support administrative information gathering, instructional evaluation, and record-keeping, rather than instructional planning and joint service delivery.

The major concept underlying the development of AIMS CoPlanner is that the microcomputer can be used to support and enhance the instructional planning and management work of resource or "helping" teachers. By this we mean that CoPlanner was designed for CMI, or what we prefer to call Computer Supported Instruction (CSI), rather than for CAI. That is, the software program is intended as an aid for the teacher, rather than as a medium of instruction for the student with special needs. The idea was to develop a computer model of the decision-making process of competent resource teachers and to build in an array of assessment, teaching and monitoring tools to facilitate teachers in that process. Furthermore, we conceived of CoPlanner as having continuity of use in preservice teacher preparation, related field practica, and subsequent full-time teaching.

Our second formative idea was to develop CoPlanner as an "open" instructional support system, which would allow users to tailor the software both to their specific jobs and to their unique styles of service delivery. We anticipated that diverse users such as resource teachers, special education consultants, educational psychologists, social workers and counselors might all wish to use CoPlanner. The program was therefore designed with a question-driven, generic, five-stage instructional planning model at its core. In the model, all of the areas of instruction (curriculum areas) are readily modified or changed by the user. Over time AIMS CoPlanner will become a personal tool, progressively reflecting the unique roles and service delivery styles of users.

The third idea underlying CoPlanner is that it would foster computer literacy in teachers who used it as an integral part of preservice preparation. Our project team was influenced by the well-documented recommendations of the Michigan Preservice Technology Training Task Force (Norvak & Berger, 1991). It maintained that

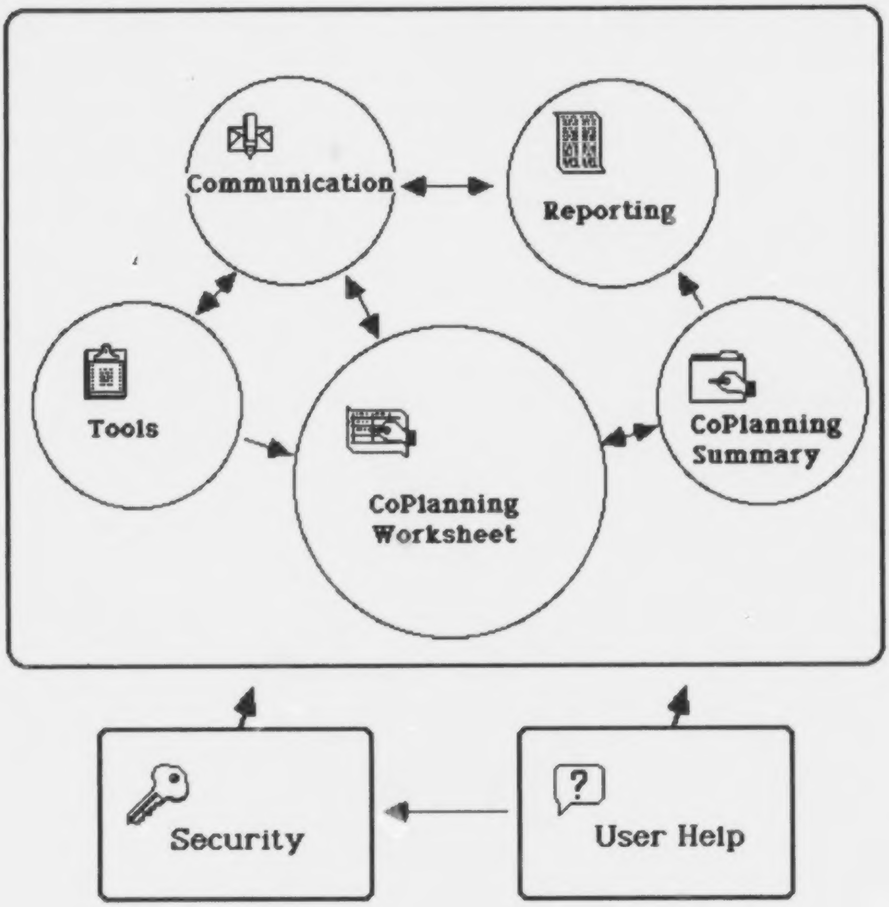

Figure 1. Elements of AIMS CoPlanner

computer technology should be fully integrated into preservice teacher preparation, both as a tool for teacher educators and for teachers-in-training. We therefore designed AIMS CoPlanner as a computer model which preservice students first learn in their on-campus courses, carry with them for use in school-based practica sites, and can subsequently use in their regular teaching positions. Our fundamental belief is that teachers who recognize the potential long-term benefits of using a computer tool such as CoPlanner, will be more willing to learn to use computers during preservice preparation.

Practical Attributes of CoPlanner

AIMS CoPlanner is a software system designed to support initial and on-going instructional planning for students with special needs, and to track such students' progress across the curriculum and over time. At the heart of CoPlanner is a two-dimensional CoPlanning Worksheet used to capture the collaborative work done on a "project", or instructional plan, for any student with special education needs. The vertical axis of the worksheet incorporates the curriculum elements established for the student, while the horizontal axis includes a question-driven, five-step instructional model consisting of the following: Information Gathering, Reflection and Planning, Teaching, Monitoring, and Reporting. In using AIMS CoPlanner, educators are required to be more systematic and collaborative in their work, while routinely recording on the computer the results of their planning and teaching. Further, using CoPlanner leaves teachers as the instructional decision-makers, while providing them with the on-line data for such decisions.

The major elements of AIMS CoPlanner are set out in Figure 1. Together these elements constitute an integrated computer support system which allows the users to: jointly assess and plan a student's educational program, even when it is not always possible for all members of the team to meet face-to face; use on-line Tools for assessment and teaching; routinely communicate with other members of the support team by on-line Mail; capture the results of all

Assessment, Planning, and Teaching on-line; generate on-going Summary Reports of work in progress; use preplanned templates to generate progress reports on students; keep confidential or personal notes on-line; and, obtain Extended Help on-line and situational help through Balloon Helps built into the software.

The final two practical attributes of CoPlanner, both mentioned earlier, are that it is significantly adaptable to the users' preferred ways of working with students with special needs and is readily modified by the user, to reflect differing curricula or program guidelines from one educational jurisdiction to another.

CoPlanner in Resource Teacher Preparation

In the professional preparation of resource teachers, AIMS CoPlanner is used both as a question-driven computer model of the role of the resource teacher and as a tool to support resource teachers in their work. Students consider the five-step model built into the horizontal axis of the CoPlanning worksheet and study ways of accomplishing each step effectively; they consider the merits of working collaboratively, first with fellow students and their professors and later in practica settings, with the host resource teacher and other teachers in the school. They also study and learn to use all of the other elements of CoPlanner such as the Project Summary, On-line assessment and teaching Tools, and Messaging and Help Systems. They review and critique on-line assessment and teaching tools, as well as create and incorporate new tools into CoPlanner. Initially all of these attributes of CoPlanner are studied as elements of the role of the collaborative resource teacher, as well as being components of the computer software. Later, however, in the practica settings, they are experienced as practical elements of a system of instruction. If the Michigan Task Force (Norvak & Berger, 1991) is correct, this approach to preservice preparation should maximize the possibility that not only will our teachers be more computer literate but that they will be more likely to use the computer in their subsequent teaching positions.

CoPlanner Across the Curriculum

Today, with more and more students with special needs being integrated into mainstream classrooms, teachers and support staff share responsibility for educational planning and service delivery. AIMS CoPlanner was designed specifically to support such group planning and teaching, both across the curriculum and in specific developmental or remedial areas. A question-based coplanning model at the heart of the software facilitates focused, systematic work by all members of the team, while the computer model of joint planning and instructional information helps team members to coordinate their efforts. CoPlanner also supports collaborative work over time, especially when there are changes in staff members responsible for a student's educational program. AIMS CoPlanner is intended for CSI both across the student's curriculum for the current year and across the curriculum for the duration of the student's educational experience.

Current Status of CoPlanner

AIMS CoPlanner is now in its third and final year of development. Conceptualization of CoPlanner took place in the first year of the project, with programming in the second year, ollowed by a brief formative evaluation at one half dozen sites in May and June of year two. The formative evaluation yielded approximately twenty-five suggestions for improving the software. These were incorporated during the July to October period of 1992. The revised version of CoPlanner is currently being field-tested at three universities and twenty school sites in Canada, the United States, and Australia. CoPlanner includes a printed manual which is also on-line as "Extended Help". "Balloon Helps" provide contextual assistance throughout the software.

Any limitations inherent in collaborating professionals using AIMS CoPlanner should become clear as the current field trials proceed. For example, lack of proficiency in typing, or in the use of computers in general, might be factors which could affect the perceived value of the software for a specific group of collaborating professionals. The software has been designed to be transparent and user friendly, even for the novice user. The information capture, storage, and utilization features of CoPlanner should also save considerable time for professionals who use it. Finally, CoPlanner will be reviewed and enhanced, if necessary, according to feedback from the current field trials.

Conclusion

AIMS CoPlanner is a computer instructional support system for resource and other helping teachers who share responsibility for the tasks associated with teaching students with special needs. CoPlanner is initially developed to support these tasks during preservice resource teacher preparation; however, it is also a tool which teachers may find equally useful in their subsequent full-time employment. As an open system, CoPlanner can be used to support collaborative educational decision-making in all components of the curriculum for students with special needs. It can also be used to develop instructional adaptations within a specific subject area for a student. Finally, it is designed to capture the results of planning and teaching, to facilitate reporting student progress, and to enhance communication among educators. CoPlanner is therefore an emerging tool to facilitate collaborative instructional decision-making across the curriculum for students with special needs.

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Copyright: Rights and liabilities of authors and users of multimedia presentations

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It is as wrong to steal someone's intangible property as it is to steal their tangible goods. Many people have no problem understanding both the legal and moral prohibitions against stealing someone else's property, but this clarity of understanding seems to get muddled when the subject matter is intangible property. When property has neither form nor substance and the ease of misappropriation increases, questions arise as to what constitutes infringement or the legal use of this property.

Intellectual property can be defined as the product of the mind. The law currently has three primary methods to protect intellectual property: copyright, patent and trade secret protection. Each of these methods is designed to cover specific subject matter and to confer specific rights and liabilities from the creation and use of this property. Multimedia presentations are a new form of communicating intellectual property. Multimedia presentations are created from intellectual property, and themselves become intellectual property.

Multimedia usually involves using several communication sources simultaneously to allow large numbers of people access to and use of resources not possible previously. While the technology used to create multimedia presentations is advanced, the presentations still display written, visual, and audio text, expression that has long been covered by copyright law.

A common problem faced by courts and the legal system when addressing new technologies is to decide whether to apply previously established rules and concepts to new technologies or to decide whether the new situation warrants an entirely different approach to find a solution. Until Congress decides to develop a new method of creating rights and liabilities for multimedia presentations, copyright law will be used to articulate authors' rights and users' liabilities. The purpose of this paper is to examine the rights and liabilities of authors and users of copyrighted materials in multimedia presentations.

Copyright Law

The seminal copyright legislation, the English Statute of Anne, was enacted in 1709 in response to the first major technological innovation: the invention of the printing press in the fifteenth century. The ability to mass produce books resulted in a host of secondary producers, or "book pirates," who purchased books for the sole purpose of copying them and reselling the copies to consumers. Threatened with the destruction of their livelihood, the original producers of the books, the Stationers, petitioned Parliament for relief. The resulting Statute of Anne granted exclusive property rights for a limited period of time, after which the protected works would be returned to the public domain. (Mills, 1989)

This English statute is the foundation of copyright law in the United States. Article I, Section 8 of the United

States Constitution says, "Congress shall have the power to. . . . promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." Copyright law protects the creation of expression. Ideas, in and of themselves, are never protected. Section 102(b) of the Copyright Act of 1976 (1988) indicates, "In no case does copyright protection for an original work of authorship extend to any idea, procedure, process, system, method of operation, concept, principle, or discovery, regardless of the form in which it is described, explained, illustrated, or embodied in such work." One is always free to create new ways to express even old ideas, but using someone else's protected expression without permission may be infringement.

The purpose of Article I, Section 8 and the Copyright Act is to protect competing interests. The language of the Constitution suggests the need to balance the interests of creators of intellectual property with the needs of the users of this property. Exclusive rights of ownership are secured to authors, but for a limited time. Exclusive rights produce incentives to motivate authors and inventors to continue their work. Compensation to authors for the creation and use of intellectual property provides a powerful stimulus to produce this product. Users want access to these products to read the works of authors, listen to their compositions and delight in the visual stimulation of artwork or fascinating graphics. Users may also want to incorporate these works into their own multimedia presentations. Since society benefits from the dissemination of innovations and technological advances, the law must strike a balance between the author's desire to control and profit from his work and the user's desire to take this product and benefit from it (U. S. Congress, House, Office of Technology Assessment,1992).

Multimedia presentations present unique copyright issues because these presentations are often a combination of works from different authors organized in a manner not intended by the original authors. Do authors have the right to determine how their work is to be used? What liabilities arise from incorporating other people's work into a multimedia presentation? Does combining other people's work create a new work that can be protected under this author's name? This paper will address these concerns.

Rights of Authors

Authors can claim copyright protection for any expression that meets the following criteria. The work must be an original work of human authorship, fixed in any tangible medium of expression, now known or later developed, from which it can be perceived, reproduced, or otherwise communicated, either directly or with the aid of a machine or device. According to Section 102(a) of the Copyright Act of 1976 (1988), works that can be protected by copyright include:

1. literary works;
2. musical works, including any accompanying works;
3. dramatic works, including any accompanying music;
4. pantomimes and choreographic works;
5. pictoral, graphic and sculptural works;
6. motion pictures and other audiovisual works; and
7. sound recordings.

According to Section 201 of the Copyright Act of 1976 (1978), "Copyright in a work protected under this title vests initially in the author or authors of the work." Copyright protection attaches automatically. It comes from the old common law right to copyright. Thus, it is not necessary to file for a copyright to claim legal rights. Nor is it necessary to display a visible copyright notice to preserve the copyright protection. "In 1988, the United States adopted the Berne Convention Act (BCA), thereby placing the United States in compliance with the copyright law agreement. Pursuant to the BCA, the requirement of a visible copyright notice was deleted for works published in the United States after March 1, 1989" (Nimmer, 1992). Copyright registration is necessary, though, if one wants to bring suit for infringement. Jurisdictional requirements imposed by Section 411(a) of the Copyright Act of 1976 (1988) require that the copyright be registered prior to initiating a law suit.

Although the notice requirement has been deleted, it is still advisable to place the notice on works to defeat any claim of innocent infringement. More important is the shift in assumptions made by users of protected works. Failure of a work to display the copyright notice does not imply the work is in the public domain. Authors are entitled to full rights to their works even if they choose not to register their works with the Office of Copyright and they choose not to display any visible notice of copyright.

The copyright law grants authors of copyrighted works five exclusive rights: reproduction, adaptation, publication, performance, and display. Each is a distinct right. Infringement takes place when any one of the rights is violated. Incorporating music from a compact disc or taking an image from a magazine and putting it into a display without permission is infringement of the rights of the holder of the copyright. "Mere ownership of a book, manuscript, painting or any other copy of a phonorecord does not give the possessor the copyright. The law provides that the transfer of ownership of any material object that embodies a protected work does not itself convey any rights in the copyright" (Copyright Office, 1992). Even though the music on the compact disc may have been bought and paid for, the compact disc owner purchased only limited rights for use of the compact disc. The purchase of the disc does not imply a right to reproduce the music in a multimedia presentation or use the music in any other manner. The general rule of law is that creators of multimedia presentations cannot use protected materials in their own presentations without authorization from the copyright holder.

Section 106(2) of the Copyright Act of 1976 (1988) also confers upon the copyright owner the right to create derivative works. According to House Report No. 94-1476 (U. S. Congress, House,1976a), a derivative work requires a process of recasting, transforming, or adapting, "one or more pre-existing works." Multimedia presentation authors who attempt to circumvent copyright protection by incorporating altered protected works into their presentations can be liable for infringement. Even major alterations of a piece are still likely to be characterized as a derivative work subject to ownership rights of the original author. "Nothing in the Copyright Act requires derivative works to perform the same function as the first work" (Kemp, 1990). Protection of derivative works grants strong, exclusive rights in the copyright holder. The Copyright Act conveys to authors broad, exclusive rights to their works.

Rights of Users of Protected Materials

The broad, exclusive rights conveyed to authors through the Copyright Act are subject to exceptions. Sections 107 through 109 of Title 17 place limitations on authors' exclusive rights. One of these limitations is the fair use exception. "Fair use refers to a privilege in someone other than the owner of a copyright to use the copyrighted material in a reasonable manner without consent, notwithstanding the monopoly granted to the owner" (McNally & Sutherland, 1986). Section 107 of the Copyright Act of 1976 (1982) describes the fair use exception as follows, ". . . the fair use of a copyrighted work, including such use by reproduction in copies or phonorecords or by any other means. . . . for purposes such as criticism, comment, news reporting, teaching (including multiple copies for classroom use), scholarship, or research, is not an infringement of copyright." Since the law has not addressed multimedia presentations as a distinct form of communication guidance can be gleaned from examining how written, visual, and audio works are treated under the fair use exemption.

"Although the courts have considered and ruled upon the fair use doctrine over and over again, no real definition of the concept has ever emerged. Indeed, since the doctrine is an equitable rule of reason, no generally applicable definition is possible, and each case raising the question must be decided on its own facts" (U. S. Congress, House, 1976b). Nevertheless, there are guidelines the courts use when determining whether a given act falls under the protection of the fair use exception. "The four factors to be considered in determining fair use are (1)the purpose and character of the use, (2)the nature of the work, (3)the amount used in relation to the whole, and (4)the effect of the use on the potential market for the work" (Copyright Act of 1976, 17 U. S. C. §107, 1982).

Court interpretation of the fair use exception created by the Copyright Act suggests that the fair use exceptions of protected works are fairly generous for classroom use. Here the courts balance in favor of protecting society's interests in disseminating information. For example, the courts recognize limits on the Constitutional monopoly granted to authors and inventors. The law allows for both single and multiple copies of protected works in limited circumstances. A single copy of an article from a periodical or newspaper, a short story, short essay, or short poem, whether or not a collective work, and a chart, graph, diagram, drawing, cartoon or picture from a book, periodical, or newspaper may be made by an individual teacher for scholarly research, use in teaching, or preparation to teach a class (McNally & Sutherland, 1986). Since multimedia presentations allow at least two or more people to view the material simultaneously, the guidelines for multiple copies of protected materials provide the better analogy for applying the fair use exemption to multimedia displays. The fair use exception for multiple copies is very similar to the single copy fair use exception, but additional restrictions are placed on the multiple copy exemption. Multiple copying must fall within the guidelines of brevity and spontaneity, and must satisfy the cumulative effect test.

Works that satisfy the brevity test include a complete poem, if less than 250 words, or a complete article, story, or essay of less than 2,500 words. An excerpt from any prose work of not more than 1,000 words or 10% of the work would also satisfy the brevity test. One chart, graph, diagram, drawing, cartoon or picture per book or per periodical issue is allowed under the brevity test. Spontaneity is described as the copying at the instance and inspiration of the individual teacher; the inspiration and decision to use the work and the moment of its use are so close in time that maximum teaching effectiveness would be lost if one had to wait for a reply to a request for permission. The cumulative effect test limits the amount of material that can be copied by a teacher during the course of a term, and limits the amount of material than can be taken from any single author. In general, copying should be limited to a single course with no more than two excerpts per author during the course of a school term (McNally & Sutherland, 1986). It is certainly possible to create multimedia presentations that would allow the legal use of protected materials under these guidelines.

Both music and off-air recordings of broadcast programming are also subject to the fair use exception. A broadcast program may be recorded and retained by an educational institution for 45 consecutive calendar days after the date of recording. The use of the recording for instructional purposes must occur during the first 10 days of the consecutive period. Incorporating recorded material into a multimedia display and then presenting the display during the described 10 day period would clearly fall within the fair use exception. Incorporating an entire broadcast into a multimedia display and then keeping that product past the 45 day limit clearly goes beyond what is allowed for fair use. (McNally & Sutherland, 1986) Uses falling somewhere between these two extremes pose the more difficult problem. The courts are likely to go back to the four factors described earlier to evaluate fair use in these situations on a case by case basis. Similar concepts of brevity, spontaneity and cumulative effect will evolve in the context of multimedia presentations.

The fair use exceptions described above apply only to classroom use. If protected materials are incorporated into a multimedia display for commercial use, to sell a product or to create a performance for an audience, then the fair use exemptions would not apply. Here the courts balance in favor of protecting the author's interests by protecting the author's right to earn a financial benefit from the work. Permission from the copyright holder would have to be granted to use the protected material legally. If protected materials are incorporated into a multimedia presentation that will be viewed by the public, a lecture open to the public or a demonstration at a commercial convention then again the use of protected material would not fall under the fair use exemption. The fair use exception as it applies to teaching covers the individual teacher's use to prepare for class and actual teaching activities in the appropriate classroom setting.

"While the bill that amended the Copyright Act to include the fair use doctrine endorsed the purpose and general scope of the judicial doctrine. . . . (there was no) disposition to freeze the doctrine in the statute, especially during a period of rapid technological change" (Mills, 1989). This suggests that the fair use exemption is likely to evolve to address new forms of communication like multimedia presentations. New definitions of brevity keyed to time rather than number of words are likely to develop. Eventually multimedia display exceptions could be carved out of the Copyright Act by either statutory amendment or court decision. Until that time, the guidelines for written, visual, and audio works provide the best insight as to what kind of use is allowed under the fair use exception.

Liabilities Incurred Through the Improper Use of Protected Materials

Users are liable for infringement caused by the improper use of protected materials, whether the infringement was willful or unintentional. The law provides for two types of actions to remedy acts of infringement. Action can be taken against the infringing work itself or against the author of the infringing work. Section 503 of the Copyright Act of 1976 (1976) allows the court to order, ". . . the destruction or other reasonable disposition of all copies or phonorecords found to have been made or used in violation of the copyright owner's exclusive rights. . . ." Section 504 of the Act allows the author to sue for monetary compensation for all losses suffered as a result of the act of infringement. The author can sue for actual damages and any additional profits of the infringer.

If the amount of loss is difficult to determine, the author has the option to sue for statutory damages. Statutory damages are damages established by law. Section 504(c) of the Copyright Act of 1976 (1988) states that in cases of innocent infringement the author can sue for amounts not less than $500, but not in excess of $20,000. If the author can show that the infringement occurred willfully, then the author can sue for amounts up to $100,000. If the author is successful in proving an infringement case, then the court may also award court costs and attorneys' fees to be paid by the infringer.

It is extremely important that teachers creating multimedia presentations are aware of the rights and liabilities created through the Copyright Act. Educators teach by example as well as through lecture and classroom presentation. Inappropriate use of others' materials in the classroom sets a bad precedent for students and fellow colleagues. Often times individuals are likely to believe that no one would care about their one or two small incidents of infringement. Catching copyright infringers may not be a national priority for the FBI, but there are organizations interested in policing the use of intellectual property. The Software Publishers Association maintains a copyright hotline where violations can be reported anonymously. Reports made by unhappy employees or disgruntled co-workers can also be the source of the complaint that prompts an investigation. "Audiovisual, music, motion picture, and software company associations use either staff or contracted investigators to check out suspicious copyright activities" (Talab, 1992).

For now authors and users of multimedia presentations have to rely on previously established principles of copyright law for guidance regarding proper uses of protected materials. Congress has recognized the need to address these issues as technology changes. "Multimedia works raise questions in two areas. First, what type of protection should they be afforded-as single works or as collections of different works in different categories. The second deals with the incorporation of copyrighted works in a mixed media work. Guidelines may be needed to determine what rights should be obtained, for example, in determining whether a multimedia presentation on a personal computer constitutes a public performance or merely an adaptation of the music or drama incorporated within" (U. S. Congress, House, Office of Technology Assessment, 1992).

Until Congress provides more specific guidelines authors and users of multimedia presentations will rely on established copyright law to define their legal rights and potential liabilities. Improper use of someone else's property regardless of the form or substance of that property is not allowed under the law.

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Helping faculty to cope with the classroom in the year 2000:
How to get a head start

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Introduction

For many teachers, the transition from traditional instruction to computer-supported instruction is not easy. Concerns such as, where do I find the time to master what I need to know in order to be able to use a computer, why should I change the way I'm doing things now, and of what tangible benefit is computer-based instruction to me as a teacher, are often expressed in lounges and hallways. Wisniewski and Ducharme add to the complexity of the situation by observing that "Most professors of teaching are far more reactors than interveners in the educational scene. It is for this reason that college of education faculty respond very slowly to changing conditions in the schools and society." (Wisniewski and Ducharme, 1989, p. 160) "Matters of curriculum and teacher education are closely linked. How the computer as subject will be taught - especially now when guidelines are absent - very much depends on what teachers know how to do with computers and the different types of lessons they are capable of organizing." (Olson & Eaton, 1986, p. 6) Hence, the use of computers by any teacher is a function of his or her perceived need, experience, and the availability of suitable hardware and software. The purpose of this paper is to describe the development of a computer-supported classroom facility as the first step in a faculty development plan and to report on the response to its use after four years of operation.

The influx of microcomputers into our K- 12 schools has opened up many opportunities for the use of computers to enhance learning in the K- 12 setting (Proctor, 1990). Like many colleges of education on other campuses, the University of Saskatchewan's College of Education has had to come face to face with the challenge of helping faculty integrate current technology into their academic activities. Given the on-going changes that are occuring in school systems, the process of integrating computers into instruction is essential to the health and well-being of any good undergraduate pre-service teacher education program.

As has been demonstrated in many other settings, the acquisition of newer and better forms of hardware and software will not solve the "personware" problem (Lombardi, 1983). In our case, the Microcomputer Classroom Project Advisory Committee took the position that computers are only valuable if they are an integral part of our academic pursuits. Any system that was difficult to use or unresponsive to user needs would not meet the project requirements.

Assumptions

Three assumptions were used to guide the development of this state-of-the-art classroom. The first assumption was that form follows function. When engaging in any new process, it is important for teachers to be able to start from a position in which they feel comfortable. Initially, the computer-supported classroom will most likely be used in a traditional manner. The lecture format will probably be the most predominant mode of instruction and the computers, like most other media, will be used as an aid to instruction. Therefore, a stand alone teaching station which resembles a conventional lectern should be available. The instructor should have easy access to presentation software, light control, sound control, and image projection. One or more types of computers should be permanently installed on the lectern. Provision should also be made to update the hardware and add desirable peripherals as they become available.

The second assumption was that, in Elementary and Secondary School settings, computers will most often likely be used as tools . The May, 1987 presentation of Executive of the Saskatchewan Association for Computers in Education made to the Saskatchewan Educational Policies Committee observed that: "... computer applications are becoming an integral part of each curriculum area at all levels of public education. We recommend that Computer Science and Computer Applications courses be separated so that Computer Science can maintain and extend its academic focus while Computer Applications be absorbed by other disciplines." Given this position, pre-service teacher education faculty will need to be able to demonstrate how small group activities can share time with the lecture and demonstration approaches. Therefore, it was decided that a discussion area with permanently available audiovisual equipment would be essential components of the classroom. "The teaching methods most likely to realize these objectives are permissive rather than autocratic in style. Permissive styles include tutorials, group discussions, role-playing, case studies, brain-storming independent study, leaderless groups and sensitivity training." (Davies, 1971, p. 84)

The third assumption was that both faculty and preservice teacher education students may eventually need to learn how to design and develop computer-based instruction. To support this type of activity, connection to a network for purposes of uploading and downloading files from a central file server, accessing large outside text and graphic databases, and an internal/external messaging systems will be required. For example, Morse concluded in his ERIC Digest of Computer Uses in Secondary Science Education that: "Science education of the future will certainly incorporate computer use—including wordprocessing, many forms of CAI, laboratory instrumentation, interactive video courseware, and scientific database searching—and the educational process will be better because of it." (Morse, 1991, p. 4)

Classroom Equipment

In the spring of 1988, with the help of a liberally discounted equipment purchase plan from the Digital Equipment Corporation, the construction of a computer-supported classroom was completed (See Figure 1.). To support the large group lecture approach to teaching, a white board, lectern, and large screen video projector were installed in the front and center of the classroom. A "one button" switch panel was provided to direct audio and video input to the projector from computer, videotape, videodisc, video camera, and broadcast sources. A sound system, 1/2 in. videocassette recorder and a videodisc player were permanently installed in an equipment cabinet located in a small area in one front corner of the room. In the other corner, an overhead projection screen was installed. Switches to control direct and indirect lighting systems and power up the microcomputers were installed within easy reach of the podium. The computer on the lectern was equiped with a hard disk and an Ethernet connection so that it can be used on a stand-alone basis and/or connected to a central file server. In the event that trouble develops with equipment as it is being used, a telephone was provided to support the rapid communication of the problem with the building computer consultant and the campus computer applications support group.

To facilitate the use and demonstration of small group teaching methods, discussion areas or "pods" were incorporated intothe classroom design. Each pod was designed to hold up to 8 students and was equiped with several networked microcomputers, a large table, a self-contained tv/videotape playback unit, an overhead projector, projection surface and a white board. Light control, independent of the main lighting systems was also provided so that different small group activities could take place in the room without one group interfering with the on-going activities of another group.

For those faculty members who may wish to explore the use of individualized methods of computer-based instruction, each microcomputer can be used on either a stand-alone basis or connected to a central file server. Class accounts can be set up to provide the instructor and each class member with access to centrally stored CAI teaching materials, e-mail and Internet. With this system, each student has full access to locally available resources and can communicate with and acquire resources from any host system in the world. While the current user/computer interface is not all that user-friendly, as Judi Harris commented during her STATE '92 workshop on Mining Internet for Teacher Education Resources Treasures, "for pioneers, the terrain is often a little bit rougher".

Faculty Response

There are currently 73 full time faculty members in the College of Education. A review of the timetable for this classroom has shown that over the last four years the number of faculty members that have made extensive use of the computer-supported classroom has increased from 3 to 14. For the current academic year, this means that a total of 11 regularly scheduled courses have been booked into this classroom. In addition to regular courses, between 10 and 20 bookings per month for non-scheduled time slots have been made by other faculty members or campus personnel to demonstrate how they have been able integrate computers into their field of instruction.

The majority of the faculty who have used this classroom likes its layout and function, although some faculty have had trouble adjusting room light levels. Although the "one switch" system for routing video sources is helpful, they find that having to use a remote control keypad for resetting the source and input presets on the video projector can be confusing. We still need to work on reducing the complexity of equipment control functions. Also, the character size for menus and system messages projected on the screen is also a bit small. Some students have difficulty reading the screen from the back to the room. Being able to adjust the display size of the text characters would be helpful. For the most part, the Ethernet network has been reliable. However, when it is down for maintenance, or crashes because of a power or equipment failure, virtually all classroom activity comes to a halt. Each faculty member needs to have a contingency plan available for use in the event of equipment failure or malfunction.

Student Comments

Student response to courses being delivered in this facility have mainly been positive. Except for having to turn around to look at the front screen when they sit at a computer with their backs toward the front screen, they like the layout of the room. Having to turn around to see what the instructor is doing is awkward. Second, some students do not like the indirect lighting system. This is unfortunate, but there is always a trade-off between keeping glare off the projection and computer screens and having a normal level of room light. Pot lights in the discussion areas help, but do not seem to be the total answer. Being able to engage in small group discussion or to consult with each other about a computer problem or subject matter problem was seen as helpful. The following comments by students are representative of student responses that have been collected over the last four years.

I like this classroom because I believe computers make it easier and more enjoyable for students, especially if you are writing a lot. I do not like to have to turn around to look at the whiteboard. I like the way the classroom is set up so that when we are in small groups we can discuss and share ideas.

Upon first entering this room, I found the constant presence of computers to be intimidating. However, I've now learned a lot about computers and I am actually starting to feel computer competent. I love the chairs. They are very comfortable and mobile.

Prior to this class, I considered myself to be completely and totally computer illiterate. Now I even find myself coming in here in my spare time to send E-mail messages to friends in my class. I enjoy taking notes on the computer and I think that this would be a great way for the future classroom to be. The only problem I have with this classroom is the lighting. I really, really dislike the lighting - it is way too dark in here. I am the kind of person who likes it to be really light, especially when I am staring at a screen for any length of time. I hate watching TV in the dark (which has forced people to ridicule me when watching horror movies). I also have a problem with seeing the professor as my back is to him. I find that if we are being shown something on the computer I have to keep turning around.

The lack of leg room under the computer tables makes it uncomfortable. But, the controlled lighting and non-distracting decor is very easy to work in.

Some positive aspects include the color of the tables, and special tables for computer or non-computer work. The negative aspects of the room would be the use of white for the walls.

I like working with the computers. However, sometimes it seems we use the computers just because they are here when a more conventional route would seem more appropriate.

Individual overhead projectors, and computer printouts are also an asset.

I, as a student, am interacting quite a lot with the person next to me when I have a question or problem. Although this might be seen as a problem by the teacher, I find it constructive. Using the computers themselves allows me to interact in an interesting way. I enjoy typing and moving the text and "interacting" with the computer, rather than simply writing on a piece of paper. For lack of a better word, it is stimulating.

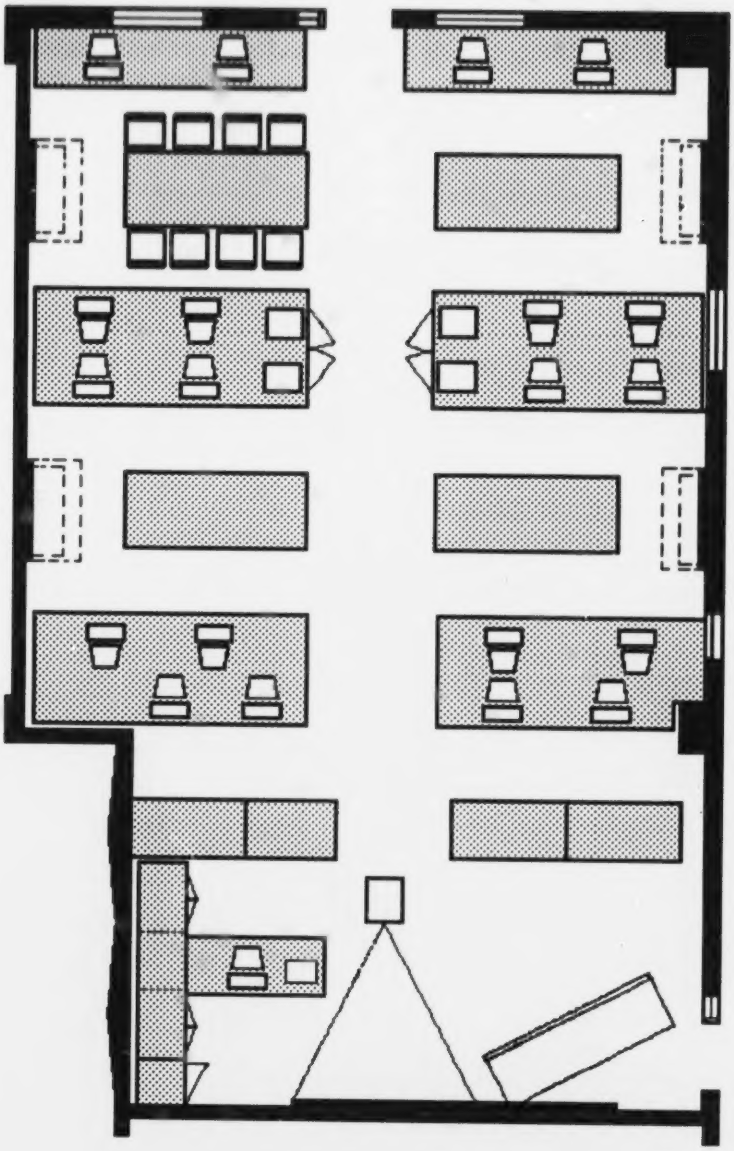

Figure 1. Floor Plan for Teacher-Centered, Computer-Supported Classroom.

The construct allows for teacher-directed as well as independent learning. The computer screen acts as a window to outside learning. While I am a firm disbeliever of classrooms with "walls", at least the computer allows the student to escape some of the necessary structure. In the case of Ed. 1037, there is quite a bit of room for innovation and application in the learning process.

I like the way this classroom is set up in stations with a whiteboard and an overhead projector screen at each station. I found that this is quite conducive to group work and the stations are in good positions so that everyone is able to see. Also I find that I rely on the knowledge of the people in my station. So we learn together.

I like the computer terminals which allow the student to become acquainted with a computer with a teacher present The lighting is a great added touch to aid in seeing the computer screen and low lighting also has a calming effect. The individuality that is promoted with separate computers. I dislike the noisy disturbance that the computer creates over the voice of the instructor. After thought: I really like the padded, rolly, flexible chairs!

I dislike the lighting, the way the computer clusters encourage cliques, no central place for the teacher.

Conclusions

The goal of this project was to help faculty develop pedagogical strategies in which teacher-student and student-student interactions are promoted through the use of the technology. Faculty members should be able to model and integrate hands-on computer access into their classes in the same way that good teachers weave video clips, calculators, reference materials and activity centers into their courses. The potential of the computer as a simulator, example generator, information processor and data processor fit well with many of the requirements of teacher-based instruction.

For our faculty, the transition from traditional instruction to computer-supported instruction has been and will continue to be a gradual process. Some early adopters have embraced the technology and have done what ever was necessary to get their systems up and running as soon as possible. Others have not been so easily persuaded and have chosen to wait a while to see how things work out. The purchase of personal microcomputers is still expensive and a lot of work has to be put into developing or redeveloping course materials. They want to see what the payoff will be on the other side. Finally, some faculty have decided that they are not prepared to make the change, or they have deemed that the use of computers in their field is not appropriate. However, given the current limitations of time, budget, and primitive user interfaces, faculty are moving in the direction of integrating computer technology into their courses, and their students are receptive to the changes being made. The teacher-centered, computer-supported classroom has been an important catalyst in the adoption process.

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ABC's of designing and developing a media production laboratory for education majors

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Introduction

Education majors that are preparing to enter the teaching profession need to become familiar with the large assortment of media, both hardware and software, that will be available for them to use in their classrooms. They also need to understand the role that media play in the learning process and the importance of appropriate applications of media in a learning situation. Teacher education will not be complete unless resources, equipment, software, and facilities are available for student use and training.

Design, Development and Implementation: The Media Production Laboratory Then And.........

The College of Education at Southeastern Louisiana University in Hammond, Louisiana recognized these needs and decided to take steps to ensure that their future teachers would be prepared to meet the technology challenge. The decision was made to design and develop a Media Production Laboratory (MPL) to be used by education students enrolled in methods and educational media classes, the College of Education faculty, and the Laboratory School faculty. A committee was formed and work began on the project. Start-up funds came from a Department of Education grant and Louisiana bond money.

The philosophy of the Media Production Laboratory was dual in purpose: 1. To expose perspective teachers to multimedia teaching methods; and, 2. To teach a variety of production skills needed to enhance these multimedia teaching methods. Multimedia was defined as "teaching with a variety of media" as well as the current "multimedia computerized concept."

The purpose of the Media Production Laboratory was to provide:

1. resources, materials, supplies and equipment for college students enrolled in educational methods and educational media classes
2. a non classroom environment in which to introduce and train college students in the uses and applications of educational media
3. a range of equipment from the basic to the high tech to be used in developing mediated instruction
4. opportunities for faculty to teach teachers through interactive technology ways to use and integrate technology into their student teaching experiences
5. opportunities for faculty to develop multimedia presentations for lectures, conference presentations, seminars and workshops.

A needs assessment was developed and distributed to the entire faculty and to a sampling of the students. The data was used to determine the equipment, materials, supplies, and resources that would be purchased for the Media Production Laboratory.

The designated room was centrally located to both students and faculty and required minimal alterations. Electrical strips were added throughout the room and a telephone and security system was installed. A large, portable storage cabinet with shelves, drawers and closet space was designed and built. Spacious tables were arranged to allow space for production and to make equipment available. The room was decorated with appropriate signs, posters and bulletin board displays.

The Media Production Laboratory opened during the summer session, 1991 with a pilot group of thirty-two education methods students. Additional classes, as well as the College of Education and Laboratory School faculties, were added each semester with full participation expected by Fall, 1992. A graduate assistant was assigned to work in the MPL for twenty hours a week. To ensure that students and faculty using the MPL were adequately trained and instructed, non graded workshops were periodically offered by the graduate assistant. These workshops provided instruction on operating equipment, production techniques, and MPL procedures. The graduate assistant was also responsible for collecting a nominal fee for some items such as poster board, laminating film and construction paper. The money collected from the sale of these materials was used to buy additional materials and supplies for the Media Production Laboratory.

The equipment purchased for the Media Production Laboratory reflects technology from the very basic to the very sophisticated. This range of equipment allows students and faculty to produce a variety of mediated instructional materials and software. Also, students have the opportunity for hands-on experiences with the variety of technology often found in public schools. Equipment was made available to the faculty and students in a three phase plan (Kemp, 1989).

Phase 1: Mechanical Level: Preparation

This level of production is concerned with the techniques of preparation. The following equipment is available: cutting board, laminating machine, dry mount press, book binding machine, Elision Lettering Machine.

Phase 2: Creative Level: Production

This level of production requires more planning and decision making. Equipment available is as follows: audio studio, video editing equipment, slide/tape programming equipment, copystand.

Phase 3: Design Level: Conception

This level of production is concerned with media that will be integrated into a learning activity. The following equipment is available: Macintosh IIsi computer, laserdisc player, CD-ROM player, scanner, black and white and color printers, LCD panel.

These three phases represent an effort to provide students and faculty the resources to plan, design and develop interactive learning materials.

The Media Production Laboratory Now...

The Media Production Laboratory has proven to be successful in a number of ways. Students using the MPL to produce resources for their student teaching experiences save a considerable sum of money and time. The number of students and faculty using the MPL has increased to the point that additional personnel and a larger facility are being considered. Funds generated in the MPL are sufficient to maintain the lab. The non-classroom environment in which students become familiar with technology and production techniques encourages peer teaching, development of individual learning styles, and group cooperation. Also, the intimidation often experienced by adults regarding technology is reduced by the interaction among students and by the interaction between students and equipment in a non-threatening environment. Several classroom demonstrations have been conducted to help familiarize the students with production techniques and new equipment.

Faculty members are beginning to design, develop, and produce educational media to enhance their lectures and presentations. The graduate assistant is available for the faculty to offer assistance regarding design and layout techniques, operation of equipment, and production skills. Also, faculty development workshops are held periodically. Several faculty members are incorporating multimedia programs into their lectures.

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Choosing computer hardware for instruction: Asking the right questions

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In the past, school personnel who were responsible for making decisions regarding district computer purchases were advised first to identify the software that they expected to use and then to make hardware choices. Although intended software use still plays a role in hardware selection, it is no longer the most critical component. With improvements in processor speed, graphics, networking capability and more sophisticated software, hardware considerations have become equally important. As schools implement site-based management, more teachers will be asked to provide input on decisions which will affect their teaching environment. They need to be able to make informed decisions. The purpose of this article is to present information on how computer hardware options can affect instructional delivery.

Prior to any discussion of hardware options, a thorough understanding of how the computers will be used in the instructional setting is necessary. The answers to the questions below will give a good basis for making informed decisions.

1) How will the computers be used in instruction? (i.e., in a writing lab, to run software, to teach programming, etc.)
2) Will the computers be used by elementary, middle or high school students?
3) Will the computers be used by one student or several students during the day?
4) Will the students need to share files? programs?

To begin, it should be stated that all computer systems are not created equal. As more hardware add-ons appear in the educational market, it is important to have machines which allow for expansion.

The way in which the machine is to be used must also be taken into consideration. For instance, some machines by nature of their hardware configuration work best as a stand-alone machine while others work well in a network situation. Some computers connect more easily to peripherals (modems, printers, CD-ROM drives, videodisc players, etc.) than others. Before making hardware choices that will affect a school's educational program for 5-10 years, some homework must be done. Suggestions are given below for questions that should be asked prior to making a purchase.

Getting Information

One of the most important issues is the role that the vendor should play in the selection process. Obviously they are an important source of information concerning product availability and cost. However, do not depend upon the vendor or salesman to give you the all the information on a system. They have a vested interest in their product and will probably not tell you about potential problems you might encounter or the limitations of the system. In a recent conversation, a district computer coordinator was describing how the vendor had assured him that high resolution graphics could be used. Unfortunately, this was not true and the computer coordinator ended up with a system that would not run several software programs he expected to use in his classes. It is, therefore, important to find some objective information sources. Since the options in the computer hardware market expand so rapidly that it is essential that a person be continually updating and revising their knowledge base, it is probably best to find a consultant who can provide this type of information. Spending $1000 for consultant services at the beginning of a district computer implementation might save years of expense and frustration.

It might also be appropriate to check with nearby districts to find out what their experiences have been with certain vendors and equipment and why they chose a particular system. State departments of education usually have some guidelines or a resource person who could provide help or direct you to other information sources.

Most importantly, keep an open mind. Just because you have used a particular system for several years does not mean that you have to stay with that system. There are many translation possibilities which would allow software from different hardware configurations to run on another system. Also, it is important to remember that the computer you have for personal use is not necessarily the best choice for your district or for different age/grade levels or all software applications.

When getting information about computer hardware, knowing the terminology that is used to describe and identify different components is absolutely essential. Ask questions about any words you don't understand. If you don't understand what is being discussed, you cannot make an informed decision. Also, remember that words may be used in different ways. For instance, it is not enough to know that a system operates on a network. There are several kinds of networks which function in very different ways (i.e. peer to peer, printer sharing networks, or client server).

Hardware options

The effect of hardware on the instructional suitability of a particular computer system is another topic which needs to be explored thoroughly. Hardware options such as processor speed, graphics display, RAM configurations, hard drive options, ports for peripheral uses, and networking capability can have a significant impact on the usefulness of a system in an instructional environment. Some questions which should be asked are:

1) How might different hardware systems affect the operation and selection of desirable software packages?
2) Does the hardware have expansion capabilities?

Perhaps the most important options involve processing speed and memory (RAM). A faster processing speed means that the program will run faster and the students will be able to use that extra time for instruction. In addition, as new software packages are introduced, they invariably take advantage of the faster processing speed.

Also, new software packages often increase the need for more RAM memory. Having the ability to expand RAM memory means that your machines will hopefully be usable for a longer period of time.

Processor speed

Each generation of microprocessors represents a significant step in sheer processing power over the previous generation. The generation places an upper limit on the size and sophistication of the programs that can be run with each processor. Which generation is usable depends on the application. For straight word processing applications even a first generation CPU is acceptable. For desktop publishing or multimedia, a third or fourth generation CPU is needed. It appears that more and more educational software needs at least a second generation CPU to run well. High end software demands at least a third generation chip and the movement is toward requiring a fourth generation chip for many applications.

The impact of processor speed on the instructional setting is that it affects how fast a program will load and run. Slow running will waste instructional time. The questions that need to be asked are: "Is the processor a third or fourth generation chip? If not, will you only be running simple applications like word processing?" and "Is the processor running at least 16 MHZ?" This is probably the minimum speed to consider at present. Looking toward the future, 16 MHZ will probably not be sufficient to run multimedia applications. Multimedia applications run significantly faster on 25-33 MHZ machines or even faster on a fourth generation machine (486 processor) running at 25 MHZ or better.

Random access memory (RAM)

The amount of random access memory (RAM) determines how large a program will run. There are thousands of excellent programs which will run with one MB (one million bytes) or less of RAM memory. However, newer programs demand more and more memory. For example, desktop publishing and multimedia applications require more memory. Windows (IBM compatible) and System 7 (Macintosh) require a minimum of at least four MB.

The question here is "How much RAM memory does

Table 1

A Comparison of CPU Generation and Speed

	Intel (IBM Compatible)		Motorola (Macintosh)
Generation	**Processor**	**Speed**	**Processor**
first	8086	8 MHZ	68000
second	80286	8-16 MHZ	68020
third	80386	16-33 MHZ	68030
fourth	80486	20-66 MHZ	68040

the computer have—will this be enough to run the desired applications?" Consult software documentation to see how much memory will be necessary to run the program.

Some systems appear inexpensive because they come installed with minimum RAM. More memory must be added immediately to do anything useful. The cost of the inexpensive system, of course, then increases.

Expansion capability

Since computer systems change approximately every two years (or sometimes even more often), it is important to choose a system that allows for memory expansion, additional disk drives, and has enough expansion slots to add a CD-ROM, videodisc player, or other optional features in the future. This is particularly important if you foresee a movement to hypermedia applications. You may want to ask the following question, "Will I want to connect a CD-ROM, network card, MIDI card, video cards, etc. in the future?"

Once you have determined if you want to connect additional peripherals, then ask, "What will it cost?" and "How many and what kind of slots (8, 16, or 32 bits) are available?"

Hard disk drives

Another important consideration is whether or not to equip each computer with its own hard disk drive. This appears to be a trend and it may soon be difficult to buy a computer without a hard drive. Hard drives work well when used by a single person. However, in a school setting, the hard drive is used by many different people. It is possible for one person to erase another person's work or to erase or alter the programs on the hard drive. If it is one computer in a classroom, then it is probably easy to monitor activity at the computer. Careful monitoring in a large lab with different classes throughout the day is not an easy task.

In a lab setting, software would have to be installed and maintained on every individual machine. In addition, a hard disk security program would have to be installed for each computer to prevent erasure of programs or files. Some programs automatically save information on the hard drive as the programs are run so that the security program would have to be set up to allow writing to the hard drive under certain conditions. The security program then has to be disabled (via password) to allow another program to be installed. This procedure—disable the security program, install the new software, reconfigure the security, and reenable the security program—is a time consuming process.

Peripherals and interfaces

Peripherals such as printers, speech adaptors, video disk players, and CD-ROMS are all important components of a computer system. The appearance of a number of CD-ROMS with excellent possibilities for educational use during the past six months has greatly increased their attractiveness. There are a number of excellent reference sources (Comptons' Multimedia Encyclopedia, MacMillan's Dictionary for Children, or the American Heritage Dictionary) which are available in a multimedia format which will actually pronounce a word or read an article out loud for a student. Having the proper interfaces, CPU, and memory can facilitate their use.

Video display

The quality of the video image is determined by two principle factors. The first is resolution which is determined by how many pixels (dots) make up the screen. Resolution is usually stated in the form # of pixels wide X # of pixels high. A resolution of 320 X 320 is considered low resolution while 640 X 480 is medium and 1024 X

768 is high.

Note that sometimes a lower resolution may be appropriate. This means that the dots on the screen are bigger. This makes the symbols larger, which may be easier for young children to read.

The second factor is how many colors can be displayed simultaneously. The more colors that can be displayed, the more realistic the image will be. Children tend to like colorful displays. A two color black/white display may not be very interesting. A four color image is very crude while a sixteen color display is acceptable for many applications. However, a two hundred and fifty six color display is very realistic. For special applications such as showing art works, a monitor capable of displaying a million or more colors may be necessary.

Some questions to ask about video displays are "What is the maximum resolution available on a video display you are considering?" and "How many colors can be displayed at one time?"

User friendliness

Ease of use is an important issue for many teachers and students. It helps the user to feel comfortable with the machine and gives them a feeling of accomplishment very quickly. This is accomplished with some kind of friendly interface (icons or menus). However, as users increase their proficiency, ease of use may become a hindrance. For instance, the original Macintosh did not have cursor keys—everything was done with a mouse. For individuals who were not good typists, this was not a problem, but other individuals found that it slowed them down.

Networks: the issue of connectivity

Networks are becoming common in school environments. These questions should be asked to determine the features supported by particular system:

1) At what speed does the network transfer information (measured in million bits per second (Mbs))?.
2) Is the network server-based or is it peer-to-peer?
3) Is there a management system (i.e. can a teacher get progress reports on what his/her students have accomplished during a particular time period)?
4) Can non-network versions of software be installed? Can the number of simultaneous users of a program be limited?
5) Is it possible to broadcast information to all workstations simultaneously?
6) Would it be desirable to be able to send information or programs to other locations in a building?
7) Can the workstations be set up to remote boot?

If the network is to be used primarily for sharing a printer, then a very slow speed (.2 Mbs) will be sufficient. If files and programs are to be shared, then at least 2 Mbs are required. Sharing large files (especially graphics images and programs) will require at least 10 Mbs. Slow networks mean that programs will usually have to be run from individual hard drives. If there is no individual hard drive, then a slow network may mean waiting several minutes for a program to load.

In a server-based network, all shared programs and files are maintained on a central file server. This makes the network totally dependent on the server, but it centralizes administration. Only one hard drive has to be maintained. Installing programs, setting up user access and security only has to be done once for an entire lab.

In a peer-to-peer network, there is no dedicated server—any machine can share the files or programs on its hard drive with any other machine. The problem is that the decision as to which files to share (and can these files be copied, changed, deleted, etc. by others) has to be made on an individual, computer-by-computer basis. This means maintaining several hard drives rather than one hard drive as on a dedicated server. The advantage is that the network is not dependent upon a single machine. Peer-to-peer works well for a small number of machines (10 or less) with light network traffic (primarily printer sharing). Many users sharing large files or programs will bog down the network. Also, individual machines may slow down. If students frequently want files on the machine you are using then your machine must certainly slow down your work while it is serving others. If you are running a big program then the people who want files from your machine will also certainly have to wait.

All networks require hard work, knowledge, and time to manage properly. Check with network users at other schools to find out what their experiences have been with particular network configurations.

Sometimes it is desirable to keep track of individual students "on-task" time. Some networks have this option (IBM ICLAS is one of these). Information is available on the amount of time a student spends using the program.

If you only want to use a program with three or four students, the cost of a network version may not be justifiable. If only network versions of software will work on the network, then individual copies will have to be purchased and run individually from floppies or installed on individual hard drives. If, instead, it is fairly simple to install non-network versions of software on the network, then individual copies can be purchased and one copy installed on the network. If the network permits, specifying how many users can simultaneously access a particular program, then simply limit the users to the number of legal copies available in the lab.

There are programs available which allow the teacher to broadcast his or her screen to all the workstations on the network (Lanschool for MS-DOS machines is an example of this type of program). It is also possible to peek in on a student's screen or broadcast that student's screen to the rest of the class. This is an efficient and cost effective way of demonstrating software and does not require an LCD panel.

If e-mail or remote locations for workstations (in classrooms, for instance) is desirable, then network cable could be installed throughout the building. Be sure to check on the maximum distance that a workstation can be from the file server.

Workstations will automatically attach themselves to the server if they can be remote booted. If this cannot be done, instructional time could be lost while a teacher goes around and individually logs each workstation onto the network. Depending on the number of machines, this could be a very time consuming process and must be done daily.

Concluding comments

If your school district is in the process of making a decision regarding the purchase of computer equipment for instruction, remember to keep these ideas in mind:

1) get objective information on the systems you wish to consider purchasing;
2) understand the terminology;
3) consider how the computer hardware will affect the instructional delivery;
4) evaluate the potential for future expansion;
5) choose graphics displays carefully;
6) if deciding on a network, evaluate carefully the different types available;
7) anticipate future needs;
8) evaluate the possibility for support (this includes vendor support, inside and outside school support, other external service support).

Most importantly, realize that saving money and getting less expensive equipment may eventually cost more money or end up in dissatisfaction. The bottom line is that teachers and students will be affected by hardware choices. It will not further the implementation of computer education/technology in the schools if teachers are continually faced with hardware that does not meet their instructional needs or is unreliable. That is the biggest obstacle that schools must overcome if technology is to have an impact on children's' education.

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TECHNOLOGY DIFFUSION

Section Editors:
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> *Reformers have the [mistaken] idea that change can be achieved by brute sanity.*
>
> -George Bernard Shaw

The diffusion of technology, like other educational reforms, is difficult to implement. In his comprebensive review of educational change, Fullan (1982, p. 79) concludes that "it takes a fortunate combination of the right factors-a critical mass-to support and guide the [change] process...." Generally speaking, those factors fall into two main groups: those that address the specifics of what should change and those that focus on *how* change can best be accomplished. Adding to the complexity, we must realize that we are dealing with a "moving target" in which "the *what* and the *how* constantly interact and reshape each other" (Fullan, 1991, p. 5).

This section addresses both the what and the how of technology diffusion in education. It begins with a paper by Viau that discusses paradigm shifts for teaching and learning in the information age. The article poses relevant questions and asks us to consider the big picture of what constitutes an appropriate education in a world increasingly influenced by information technologies.

The papers that follow document efforts to integrate technology into K-12 schools. Brown and Logan report on eight innovative projects funded by the Washington State legislature that involved computer-based technologies. The authors specifically examine levels of implementation and teacher concerns in those projects. Ritchie and Wiburg focus on characteristics of teachers who adopt technology and discuss the implications for staff development in school settings. Bennett adds to this discussion by presenting a model for staff development grounded within the framework of Maslow's theory of motivation and Bloom's taxonomy of the cognitive domain. This model considers both the affective and cognitive needs of teachers who are resistant to technological change.

The next group of papers focus on efforts to diffuse technology into colleges of education. Yopp cites preservice teachers' lack of computer experience and documents efforts to ameliorate this problem. Smith and Wilson describe a demonstration program to prepare teachers to deal with innovations in curricula, assessment, and the use of technology. Ramquist also addresses the needs of preservice teachers in describing his university's inclusion of new interactive technologies in its media lab. Interestingly, Ramquist notes a change in program orientation from a skills approach to a greater emphasis on what can done with the equipment. Finally, Reehm and Kolloff document one university's attempts to keep pace with the increased technology use in K-12 schools

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mandated by Kentucky's sweeping reform efforts.

Faculty development for teacher educators is a critical concern addressed by the next set of authors. Topp, Thompson, and Schmidt review the literature in this area and offer a three-year model that is currently being implemented at their university. Poage describes a proposed model for faculty development and technology integration that is based on roving, multimedia workstations for use by selected faculty. Abate's work focuses on an evaluation of efforts to integrate videodisc applications throughout a teacher education program. He documents the advantages and implementation problems experienced by education faculty. Regenstein describes a series of faculty workshops designed to help technical neophytes to learn to use information technologies. The focus of these workshops was to support the creation of instructional materials based on the individual teaching needs of the participants. Finally, Wardlaw describes another staff development project: The Model Schools Program. His paper examines efforts to increase the effectiveness of faculty and staff at his university's Economic Opportunity Center in using computer applications.

The remaining papers focus on critical components of the change process: organization, leadership, and funding. Cafolla and Kauffman describe the quality management philosophy of Deming and suggest that colleges of education could take on a leadership role with technology and school reform by adopting such principles. McKenzie documents a collaborative effort between a college and school district to provide educational leaders with professional skills and knowledge to plan for technology use at their sites. Strudler and Powell describe their work with action research to prepare teacher leaders and change agents for technology use in K-12 schools. And finally, Haney, Enneking, and Sabelli discuss funding opportunities offered by the National Science Foundation to support innovative technologies in pre-college education.

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The mind as a channel: A paradigm for the information age

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'To a man with a hammer, the whole world looks like a nail.'

Reality is not really *seen,* it is perceived and interpreted. We build our worlds out of observations, experiences, and information that we have gathered ourselves or gleaned from others; we use familiar models to organize this material in ways that make sense to us. Of necessity, our conclusions are based on how information that we have gained relates to what we already know. Unfamiliar or conflicting evidence, which we cannot classify within our personal frames of reference, may be disregarded as irrelevant or rejected as unreliable. Yet, in times of major paradigm shifts, such as the information age transition that we are in today, our old models may hamper us in our struggles to understand the realities of the present. It behooves us to examine our definitions and assumptions to see whether they will hold their currency in the future.

Three Technology-Related Educational Schemas

Perceptions of what education is about are tied to dominant information-handling technologies; philosophical changes accompany technological ones. For example, the oldest form of education is simply imitating what other humans do. When a child lives with a hunter-gather clan or as an apprentice in a workshop, education is active, hands-on, and based on physical experiences. Information is stored in human minds, and teaching is showing how, explaining why, and involving the learner by enlisting his/her help in the task. Learning is watching, imitating, participating. An educational experience consists of doing something intimately grounded in the activities of life itself: making a clay jar, skinning a rabbit, spearing a fish. The learner uses the actual tools and materials that are involved in the task: the experience is totally coherent in its context, and the product is immediately useable and valuable. Competence is judged by what the learner can make or do, and educational philosophy can be summed up as *live it!*

The invention of writing brought new structures to education. When reading or writing, the educated person sought removal from the bustle of 'normal life', intellectually, posturally, and often even physically. The reader or writer focuses concentrated attention on a manuscript or writing surface, often while sitting down. Initially, the learner learns *how* to read and write, but later he/she learns about the real world from an intellectual distance, by reading about it. This model of education benefited from the invention of paper and the printing press, and for a long time it prepared the learner to record and use information in adulthood. Information was stored in books, and education consisted of learning what information was available. The tools of education were materials supporting written symbols. Hands-on interaction with the 'real world' continued to be the education of the working classes, but the intelligentsia were not expected to learn practical skills. For the student in the writing tradition, removal from the bustle of community life and a disciplined obedience facilitated the educational objective — *know about it!*

Electronic media are changing our world again, but, as so often happens when new technologies are introduced, we are using them in ways, and for purposes, which were served by an earlier technology, in this case, paper and ink. The written story, the picture book, the slide show, the movie, the television show, the VCR tape, and now the video-disk form a continuous progression: generally speaking, only the video disk, when interfaced with the computer, may have materials prepared in one sequence with the intention that they may be used in another. Random access thinking breaks with the sequential, linear tradition of the written word. Computer software copies the flashcard, the workbook page and, to some extent, the silent reading lesson. We are still filling the students with information *about* the world, information that, in true written-word fashion, is removed from its context and represented rather than experienced directly. This information may be learned in a piecemeal fashion and never really integrated into a coherent understanding. As the flood of information continues to inundate us, our educational objective must change. Information is no longer simply organized, stored, and made available; it has become a dynamically changing, random access flood, and it will not help to try to simply *learn about it* — our students must learn to *shape it* — to select and shape information as our forebears shaped and selected wood and clay. To do so requires understanding and judgement as well as knowledge.

The Limitations of Our Traditional Paradigms

As educators we are talking about preparing students for the information age, and exploring avenues for doing so. Of necessity, much of our time is spent on piecemeal tasks and issues: designing units that use the computer, evaluating software, learning applications, becoming familiar with new hardware products. Yet, behind the plethora of practical details, enormous, unmanageable issues confront us; caught in the quintessential information age dilemma, we struggle to cup some water in our hands, and are swept away by the river. We try to hold onto those aspects of our existing paradigms that represent 'how things are normally done' — but the paradigms, too, are being torn away. We ask larger questions: 'What should the curriculum be?' 'How should the classroom be organized?' but even questions as important as these are peripheral issues. Information has been released from its physical embodiment and set free to flow in streams of energy: its form, its content, its quantity, its accessibility, its velocity, its organization, all are undergoing violent mutation. We must try to understand this transformation, which is occuring with dazzling rapidity; we must try to isolate those skills and qualities of mind which will empower our children to utilize this flood. This is no easy task. We must determine what needs to be done, and we must understand what it is that we are trying to do.

There can be no doubt that people need some practical world skills, and that there is some basic core of '*information about*' that everyone should have. However, using persons as repositories of '*information about*' is not going to work well, for several reasons. For one thing, knowledge about the world is doubling at ever increasing rates. No scholar will be able to stay current in his/her field unless he/she chooses to pursue an ever-narrowing specialization. As the number of specializations increases, the numbers in each may well decrease, leading to fragmentation of expertise in many disciplines. Another problem is that knowledge is no longer static: yesterday's knowledge is being superceded by changing attitudes, political developments, and recent discoveries. Much of what we teach our students today may not be seen in the same way in twenty years. Additionally, human memories are fallible. The information that students toil to memorize can be easily stored in computers and be made subject to instant access by people with computer skills. The computer will hold the information unchanged, (whether it is entered correctly or not.) As memorizers, we cannot compete with computers. The best use of human minds in the future will not be information memorization but transforming raw information into useful knowledge.

Human Information Processing

People have always processed information. A great deal of what humans do is comparison and classification: 'this is like that because...' We compare objects, ideas, relationships and systems. We match new material to known models. For example:

objects: Your cookie is bigger than mine.

But which has more chocolate chips?

ideas: Being truthful is more important than being kind.

Is this always true?

relationships: The earth is our mother.

Does this imply responsibility toward the earth?

systems: Jupiter and its moons are similar to the sun and its planets.

Does Jupiter provides energy to its moons? What kind and how?

models: The brain is like a computer.

Is creativity, then, a malfunction?

The computer can be programmed to store the statements, but it takes human beings to ask the questions. Much of human progress depends on asking good questions, a skill which is becoming increasingly important. Can this skill be taught?

We know that the future will present us with an information overload. We must learn how to decide which information is important and which is trivial, which may be true and which is questionable. We must set priorities and balance the short term against the long term. We must learn to compromise. None of these skills can be learned by memorization. We need a model of education in which performance is not central, in which information is not central, and in which thought, and even wisdom, are. Can we construct such a model?

Mind-Shaping—For What?

Human beings are frighteningly malleable. They accept any conditions as normal if they are born to them. And education shapes young humans. Shapes them — for what?

In the hands-on pre-literate society, *practical functioning* is the key. The young human is shaped to be an intelligent tool, to have the most efficient, useful skills. The human serves by doing tasks.

In the written word society, *knowing about* is the key. The young human is filled up with knowledge, like a jug being packed with wet sand. Often the isolated grains of knowledge never fuse into a coherent mass, and often capacity is valued over coherence. The human stores information, and reorganizes and applies some of what he/she knows.

But in the electronic age, it is not enough that skills be learned or information stored. There is a constant flow of information, which must be evaluated, sorted, directed, and utilized. The mind, no longer a jug for storage, becomes *a channel* through which information flows. The minds of the information age must be able to take in information that is constantly being revised, to integrate it across relevant fields of expertise, and to apply it to the problems of the moment. They must be able to compare and evaluate items of information, selecting and prioritizing useful data from the flood.

But sorting and sifting information is not enough. The output of the problem solving process must be useful, relevant, coherent, and, above all, communicable to a diverse group of receivers. The minds of the information age must be superb translators. As the world becomes a global village, all peoples must face the same problems, but cultural and religious values influence how these problems are perceived, and determine the acceptability of possible solutions. Solving individual problems, even trivial ones, often seems impossible in today's world. We are unable to lift our thoughts from the stones in our shoes to the avalanche thundering down upon us. Time is short. We need minds that can see perspectives other than their own, that can compromise without losing sight of larger objectives, that can translate ideas from one culture into the argot of another, that can move models of solutions into new areas of application. These skills have always been in short supply. Can they be taught — or learned in appropriate situations?

New Minds, New Methods

If we are to use our minds in new ways, we need to change the ways in which we educate our children. . How can we move us from the model of mind as information-holding jug to the model of mind as an information-directing channel?

First, information must be seen as dynamic rather than static. Rather than memorizing facts, students must learn to use and create models to help them to organize information. Students must develop mastery of basic skills, but models must be utilized from the beginning. Information in books is dead information; the action of the living human mind brings the information to life, gives it relevance, utility, and purpose. Students need to experience the sense of bringing knowledge to life, to see knowledge as something that empowers them — to do, to produce, to create.

Learning must become the primary focus of activity in the classroom. Traditional education focuses on the teacher as the authority, exercising control over the students and selecting the material that will be taught. Most of the time, the teacher talks and the students listen. Learning becomes a passively received information transfer, leaving the student as an object, a jug. We need to think about teaching and learning differently.

New Perceptions of Our Students

Are students objects or agents? Objects need to be shaped and formed; student-objects can be seen as raw material when they come to us. As objects, they are easily dealt with philosophically; equality of opportunity can equal *sameness* of treatment. As objects they can all be evaluated by the same process. The fact that they do not all achieve identical SAT scores can be somehow laid to defects in the student or his/her background. This model seems to 'work' on the majority of students. It can be administered and overseen in a rational way. Unfortunately, the products of this system are beginning to show inadequacies; displaced workers, rising joblessness and homelessness, obsolescent *people*, attest to the hard truth that this product is no longer what the society needs. As the mismatch between society's changing needs and the schools' traditional 'product' increases, we will see more stress in the job market, more companies doing training and increasing demands for information-channel people, who are already in short supply.

As agents, students are active persons, predisposed to growth, learning, and development. They demonstrate some power of self-direction; they need opportunities, nurture, the teasing lure of half-seen possibilities. In this model, the teacher is not the gardener, but the soil, providing continual support and essential nutrients. The teacher is sensitive to the needs and maturity levels of individual students, as well as to the overall skills that each must acquire. If the student is unfolding himself/herself it is possible to foster the individual development of each student's powers. In this model, learning is indeed the the primary focus of activity in the classroom. At times the teacher may be almost invisible—as the ground is not noticed in a verdant garden. But the teacher's support, guidance, encouragement, and judgement, informed by understanding of the individual student and a generalist's vision of the connectedness of knowledge, is the *sine qua non* of the educational enterprise.

If students are to develop from within, they must be allowed to invest themselves in the learning process. The classroom of the future must provide a safe environment in which students may experiment, take risks, and play with processes and ideas. The 'one right answer' can no longer be the dominant focus of instruction: the process by which decisions are made and information is evaluated must be explored, so that students can see why one answer, or several answers, provide the acceptable solution(s) to a problem. The competitive ethos in our classrooms must give way to a cooperative one: without cooperation, we will be unable to solve the problems that face us, and cooperative behavior is learned behavior.

Organizing schools around the students as agents will be challenging because students differ, and their needs differ, also. The educational process cannot lead to uniformity of results. We must teach a core of skills to every student, and aspire to expertise and excellence in some area for every one. We must rid ourselves of preconceived ideas about what students are capable of. We must reward initiative, not just obedience, and be aware of students who think in other modes, who have gifts for divergent thinking, creativity, synthesis, empathy, and social facilitation.

Administration of these schools will be challenging. Teachers must have more power and responsibility — because teachers are the ones who know the students best. Record keeping will increase in importance as students go through school at different speeds. Curriculum will need ruthless examination, and classroom organization will change as mixed-age students work together. New evaluation systems will need to be devised, systems that look at the student as well as at the skills and information learned.

Changes We Can Make Today

Questioning

How can we begin to help tomorrow's schools take form? First, by focusing on finding good questions. Often, the form of a question determines the shape of the answer; rephrasing questions may lead to a wider choice of options. We need to ask *big* questions, courageous questions, about the purposes of education, the nature of knowledge, the relationship between teaching and learning, and what kinds of people we will need in the future.

Identifying Core Skills

Second, we need to identify the basic skills that every citizen needs to have, and to be sure that every student learns them. Students should come out of our schools with the conviction that whatever is learned can be related to what is already known and can be made meaningful by the creation of coherent patterns of relationships.

Seeing Students as Individuals

Third, we need to start to see our students as individuals. Our students are becoming more diverse. It is important that we start to consider new options: laying out individual study plans around a core curriculum, allowing students to go through school at varying rates, encouraging group learning and problem-solving, opening the classroom to a wider age spread. Technology makes individual record keeping possible, and computers provide work stations around which groups can gather and focus. We need to offer a variety of pathways to learning and give every student the opportunity to strive for personal excellence. A self-concept that is built on the opinions of others, however well respected, cannot be substituted for a self-concept built on personal achievement and growth. Every student must attain mastery of the basic skills and competence in areas of personal choice or potential.

Focusing on Process

Fourth, we need to teach students to focus on process. Students need to integrate knowledge from different subject matter fields, and to digest new material and make it a part of their mental structures. Doing this is time consuming, but if what is learned is well integrated it will form a foundation for later learning. Initially, teachers will have to point out connections, but if students are constantly encouraged to relate new material across subject matter lines, they will come to seek out interdisciplinary connections themselves. Teaching processing will make use of group work, discussion, writing and projects so that students can practice critical thinking, logical analysis, thinking from different perspectives, and compromising when processing information.

Providing and Using Models

Fifth, we must provide students with a variety of models of systems and relationships.. Much of mankind processes information with the use of metaphors. The scientific process, with its emphasis on accurate observation, independent verification, and rational interpretation has focused western minds on trying to see something *as it functions and as it is* while screening out much of the context as irrelevant. This disciplined concentration is a very powerful way to process information, focus on specific problems, seek relevant data, and observe events under controlled conditions.

But the scientific model is not the only way to think. It may impede the solution of some social problems. The scientific mode of thinking may focus on the narrow dimensions of a problem to the exclusion of intractable attitudinal and affective factors and assumptions which cannot be dealt with rationally. Here metaphoric thinking may be helpful; it can reduce the complexity of a situation through the use of an image which clarifies, unifies, and inspires. Metaphoric and allegorical thinking draw on models to interpret the world and to create relationships by connecting unfamiliar situations to deep affective roots: an idea such as 'the family of humanity' transforms foreigners into kin with a simple phrase. Students need to have a repertoire of organizational structures for possible application to new information and experiences. Students need to learn and practice the use of models, and to think critically about them. A superficial 'fit' can be dangerous, precisely because it *does* link a new situation with powerful emotional roots. Metaphoric models pervade our thinking, and such ideas as a human being being 'a cog in the machine' fit our minds so comfortably that we do not stop to question them, or to criticize the actions and policies that can flow from inferences implicit in unexamined assumptions. We will *have* to use models to bring coherence to the chaos of the data stream; our future citizens need a wide repertoire of possible models to choose from, and a critical approach to any model that is chosen.

Using Technology

Sixth, we need to make information technology both transparent and visible. Making technology transparent means saturating our environment with it so that it is accepted as a matter of course. But, though technology has made many changes in our environment, the most significant and transparent influence of information technology is on our own minds — on how our thinking is affected by using technology, and models drawn from technology, to organize our thinking about things that are not related to technology at all. This influence on our perception of reality must be made explicit. It is becoming increasingly difficult to distinguish the images of the real from the images of the unreal on television, to distinguish the relevant from the irrelevant in computers that record all information with equal fidelity, to distinguish between the urgent and the important. Yet making these distinctions is what we must learn to do, and what the thrust of our education must further.

Finding Courage to Begin

A journey of a thousand miles begins with a single step.' Changing education is a daunting task, because we must review our assumptions, challenge our traditions, change our practices, and redefine our goals. But the task is not impossible. We must start where we are with such courage as we can muster—by discussing ideas with our students instead of just explaining them, by taking the time to build bridges between the disciplines, by showing connections between scientific discoveries, social conditions, and historical events, by using models and metaphors, and by focusing on questions and problems rather than on answers and solutions. We must let the students begin, too, by encouraging them to work together, to rely on one another, and to validate solutions by thinking critically about them, rather than by asking us if they are correct. We must give our students the sorts of challenges that will allow them to practice the skills of locating information, judging its value, and utilizing it to serve some purpose that interests them—and to do so in both social and individual settings.

A jug can only dispense what it contains—a channel is open to a flow, a *flow-through*. The minds of tomorrow must be open, able to deal with information that changes and grows. The models of education that served us well when knowledge was a permanent possession, inscribed on stone and paper, no longer fit; the age of hard copy is gone. Knowledge has become a distillate, refined from the flowing data stream. Currency has displaced the imprimatur of tradition; relevance and focus replace the encyclopedic completeness that we once prized. The image of the jug can serve no more. We need to move toward a new educational metaphor, one that will clarify the roles of our students and elucidate the nature of our relationships to information, knowledge, and learning. The information-age mind is a channel, not a jug. From us, this transformation of conception demands courage, but courage for a cause: we can advance our educational goals from *knowing about* to understanding, from collecting all the facts to selecting the relevant ones, from holding information to shaping its endless flow. We can prepare our children to be shapers of the world—and we can begin today.

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Technology in the schools and the challenge of collaboration

Report from the Washington State Schools for the 21st Century Program

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When the 1987 Washington legislature initiated the Schools for the 21st Century Program, they hoped to stimulate educational reform by supporting innovative school restructuring at the local level. To do so, the State Board of Education funded twenty-one programs across the state. Eight of the selected schools had proposed reforms that involved the implementation of innovative technologies, the subject of this discussion.

The Instrument

The difficult task of educational assessment, already complicated by the cost effectiveness issues of implementing technology, is complicated further by the difficulties of assessing *innovative* programs. After all, as Siortnik observes, "A generic evaluation process intended to measure and compare progress presents a contradiction to the program's intent" (1991, p. 1). The innumerable variables involved with assessing the disparate innovations in the Schools for the 21st Century Program, including the variety of technological innovations, required an appropriately innovative approach to assessment.

After extensive consideration, we chose the Concerns Based Adoption Model (CBAM). The CBAM is a tool developed by Hall, G. E., Wallace, R. D., Jr., & Dossett, W. A. (1973) that focuses on the perceptions and behaviors of the *teachers and administrators* involved in the change process.

The selection of this tool reflects a bias that may be particularly pronounced when applied to the implementation of technologies, for it assumes that it is not the technology but the participant who uses the technology that determines educational change. If the computer alters our behavior in undesirable ways, in other words, then we are obligated to use it differently, or not at all. We acknowledge the possibility that this notion of computer as tool may ultimately prove to be naive, since technology itself may be changing not only the way we learn, but the meaning of learning itself. Nonetheless we sidestep this debate for now by asserting that it is the context of technological implementation that precipitates educational change, and for decision makers, it is the behavior of individual faculties, administrations and districts—the school culture in general—that is most responsible for shaping that context. Moreover, the assumptions underlying the selection of the research instrument, as we will explain, were supported by our findings in interesting ways.

The dimension of CBAM most germane to this discussion was the Levels of Use (LoU) interview process, which also assumes *individuals* accomplish change (Hall, G. E., Wallace, R. D., Jr., & Dossett, W. A., 1973), and which also allowed for adaptation to each project's specific innovation configuration.

The LoU, like the CBAM, does not explain causality or measure attitudes, motivations or other affective aspects of the user; it delineates *behaviors* of innovation users.

The LoU is used to discern the following eight discrete levels of an innovation's use:

0 - Non-Use
1 - Orientation
2 - Preparation
3 - Mechanical Use
4 - Routine
5 - Refinement
6 - Integration
7 - Renewal

The Non-Use level, like orientation and preparation, indicates the educator has made no effort to use the technology. The Renewal level reflects reevaluation, the making of major modifications in the use of the innovation to enhance its impact on students, for instance cross wiring computer monitors so students see the screens of the students working across from them. Mechanical use reflects a user who still struggles with maintenance of the technology in ways that do not enhance curriculum or impact students, whereas the routine level, unlike the refinement level, corresponds to those instructors who have no difficulties operating the technology, yet also who do not explore additional possibilities the technology makes available.

In addition, the following seven categories are assessed for each level:

1 - Knowledge
2 - Acquiring information
3 - Sharing
4 - Assessing
5 - Planning
6 - Status reporting
7 - Performing

The matrix provides a detailed assessment of each participant's use of an innovation. An educator, for instance, might be at the preparation level in the assessing category, yet at the refinement level in the performing category.

We conducted the LoU interviews on site December, 1991 through February, 1992. The interviewees were randomly selected clusters of staff involved at each site, reflecting 25% of the staff at each school.

Findings: Integration and Renewal

Of the twenty projects we visited, the eight projects that implemented technology ranged from simple computer grading systems and drill and practice software applications to word processing and networked communications.

A common difficulty expressed with computer innovations was logistics. Most classrooms had only one computer, which obviously limited hands-on student participation. Scheduling was also a problem, yet as one Sunnyslope teacher explained, "Students often have to work in pairs, but in lots of ways that's a strength because they can use each other's strengths and get help that way."

This praise for the collaboration facilitated by computers in the classroom, however, countered our more general findings: there was a significantly low level of integration or collaboration of computer use among school staffs, particularly compared to the stable and high routine use levels and the surprisingly high use at the innovative and renewal levels of implementation. This finding was even more surprising when it was compared to the level of collaboration found with other innovations. See Figure 1 below:

Perhaps the disproportionately high use of technology at the renewal level was simply representative of the solitary nature of those who explore with computers. Yet the stable mechanical and routine use levels, with the indication of the incipient mavericks at the refinement level, as well as the low level of collaboration among staff members points out an interesting trend in the implementation of technology. Ironically, though the level of use by individuals implementing technology reported diminished collaboration *among the staff*, among students, teachers interviewed supported Dickinson's findings that computers create an on-task, noisy, *collaborative* social organization (Dickinson, 1986). Hawisher's research also confirms what teachers reported: computer use generates great enthusiasm and an increased positive attitude toward school (1989). As one teacher noted, "The students have a sense of pride about coming [to school] because their parents talk about faxes, modems. . .and communication and computers, and [students] then see those things in [their own] workplace."

This disparity between a staff's perceptions of their own use of computers compared to their perceptions of their students' use of computers has provocative implications. Why are faculty so often involved with collaboration with other innovations, yet apparently so reluctant to collaborate when the innovation is technology? Why are they nonetheless so excited about reporting their students' collaborations and enthusiasm? Is the discrepancy attributable to generation differences? Or do computers exasperate ego clashes and turf wars—the computer whiz versus the technophobe—and the stigma of paid professionals unwilling to confess an inexperience they mistake

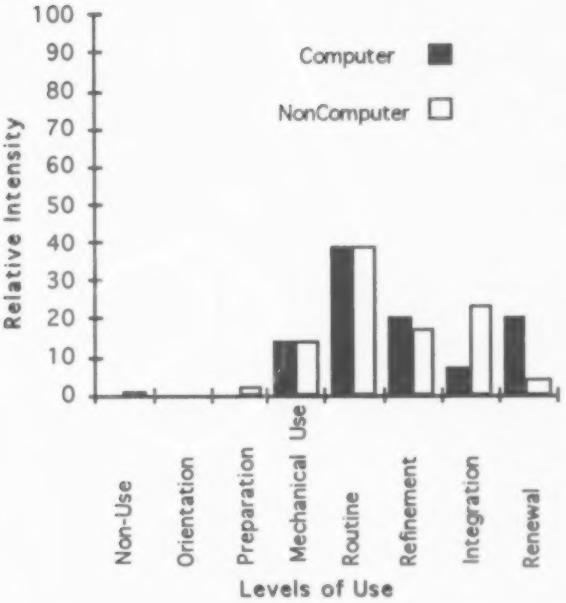

Figure 1. Computer vs. non computer projects

for ignorance? Perhaps the logistical problems, for instance, or vying for lab time, encourage selfishness and diminished integration among faculty? Does the discrepancy suggest, perhaps, that a teacher's collaboration with students who respond so positively to computers supplants the inclination or need to collaborate with colleagues? Does it suggest collaboration itself stifles innovation? Or is it a differential and complex confluence between purpose, population, attitude, aptitude and environment?

Conclusions

A closer look revealed that integration levels were innovation specific. Grading programs and most drill and practice programs correlated with high routine and mechanical levels of use and probably do not require much attention to staff collaboration and even less to renewal and innovation. On the other hand, the enthusiasm reported among students tended to be apparent among staff when the innovation was designed or implemented in ways *intended* to increase communication and collaboration, as it frequently was introduced to students, and which supports the initial assumption that we view technologies as tools rather than ends. For instance a number of teachers at one elementary school praised the increased communication resulting from the new networked computer system, and many modified their use of the technology in ways that impacted students. Almost all of the staff enjoyed the greater communication with their colleagues, with the parents of their students, with their students who also communicated with students in other countries. Almost everybody enjoyed the greater spirit of collaboration, in this case counter to the general findings associated with the implementation of technological innovations because of the *nature* of the innovation—e-mail. The implications culminate with one teacher's enthusiasm for the promised district-wide network, proclaiming that electronic mail was "just wonderful," and that when the central office was finally hooked up, they would "be just inundated with messages."

So what is the message we should send the central office regarding the implementation of technology? Certainly our requests for technology should be informed with discretion, with clear purpose—a purpose that would nonetheless be wise to include room for innovation and play. After all, if our goals for using technology are to encourage isolated, routine and mechanical use of expensive technologies, then we can be satisfied with mechanized grading and drill and practice programs. If we want to encourage collaboration that excites us as teachers when we see it among our students, then the question is more complex, and more complex still if we want to extend that excitement in ways that both foster and reflect our own collaborations.

It may very well turn out to be that technology is not value free, but if there are implicit values in the technology itself, then rather than free us as educators from responsibility for those values, it increases our responsibility for the values we encourage with our *use* of technology.

It will take time to ascertain which approaches to implementing technology actually improve education, but even more time if we fail to plan structured time to work together. For now it will help to recall, as Liberman and Miller remind us, that collaboration is an "innovation in and of itself" (1991, p. 33) and that previous research strongly suggests that the greater the collaboration, the greater the facilitation of academic achievement, and the greater the transfer to individual learning (Dansereau, D. F., Collins, K. W., McDonald, B. A., Holley, C. D., Garland, J., Diekhoff, G., & Evans, S. H., 1979; Sharan, 1980; Slavin, 1980, O'Donnell, A. M., Dansereau, D. F., Rocklin, T., Lambiotte, J. G., Hythecker, V. I., & Larson, C. O., 1992, & McDonald, Larson, Dansereau, & Spurlin, in press).

As we bring new technologies into our schools and classrooms, it will not be surprising to discover, finally, that what is effective with students will be effective with teachers as well.

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Integrating technologies into the curriculum: Why has it been so slow, and how can we speed it up?

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Introduction

Tree Top High School services a population of middle income families in a semi-rural community. Four years ago, the school board encouraged the principal to purchase 30 computers so that the students would have the ability to keep up with technologies relevant to the 21st century. Although somewhat hesitant, the principal initiated the purchase and distributed the computers to the staff. Today, the teachers joke that the two main purposes for the computer are to impress the public and to catch dust. Although occasionally used by teachers to write letters or average grades, most computers sit idle throughout the day.

At a similar location, Forest Glen High School also purchased 30 computers 4 years ago. Today, technology is pervasive throughout the campus. Students and teachers use the equipment before, during, and after school. The computers are distributed throughout the school and are an integral part of the curriculum in almost every class. At Forest Glen, the main computer use is not word processing or content specific drill and practice, but activities which help students develop higher level thinking skills and think more deeply about academic concepts.

Although these scenarios are fictitious, situations not unlike these exist throughout our educational system—similar populations and technologies, yet vastly different results. What causes one school to implement technology more efficiently than another? How much do training and pedagogical orientations contribute to the use of technology? What kind of administrative support is most conducive to overall computer use? The purpose of this paper is to examine these and other variables which contribute to the divergence of implementation, and to offer suggestions as to how to improve the integration of technology throughout the curriculum.

Pedagogical Orientation

Researchers have recently identified two major variables which account for how well technology is integrated into the curriculum. These variables include the pedagogical orientation of teachers and administration, and the training provided to help the faculty incorporate the new technology.

In a study established to determine characteristics of teachers who had a either a high level or low level of technology implementation in the classroom, Honey and Moeller (1990) identified four pedagogical orientations and practices. Teachers with a high level of technology implementation were fairly homogeneous, and tended to focus on instilling a sense of curiosity and desire to learn in their students. They used technology not only as a tool for thinking, but a tool for thinking and learning more deeply about content. They reduced classroom time on the acquisition of facts and devoted more time to an inquiry-based approach which helped students develop critical thinking skills. Teachers who do well at integrating technology into the curriculum often view the importance of education in how students approach solving problems, not on scores from tests of basic skills (Tucker, 1992).

Honey and Moeller (1990) found that rather than "teach" technology, these teachers used technology as a process-oriented approach to enable students to reach curricular objectives already in place. Allowing students to explore and use applications such as desk-top publishing, telecommunications, and multimedia, students not only expanded their educational horizons, but learned more due to their increased enjoyment in finding creative ways to master curricular objectives.

Characteristics of teachers with a low level of technology implementation were more heterogeneous, ranging from process-centered to more traditional. These "low implementers" tended to fall into two groups, one of which consisted of those who were reluctant to use technology because of personal fears and inhibitions. Many in this group stated that their first experience with technology had been a negative one, and because they had not seen appropriate examples in their subject area, they lacked ideas of how technology could be incorporated into their curriculum. The other group stated the lack of available hardware and software precluded their entry into technology usage.

Teachers with practices more common to the traditionalists view of education also had a low level of technology implementation in the classroom. They maintained very structured classrooms with higher levels of discipline, emphasized content rather than processes, closely followed textbooks, and used classroom lectures as the major means of teaching. One of the main reasons given for their not using technology in the classroom was the viewpoint that it was too disruptive. When technology was used, its purpose was to reinforce basic skills or boost motivation rather than enhance the curriculum.

None of these groups in Honey and Moeller's study felt that they had received adequate instruction on the use of technologies in the classroom. Even those with a high level of implementation stated that their formal training had been less than desirable, and that they had mastered aspects of the technology because they were highly motivated and had used their own time to learn it.

We can conclude from this that if we desire to increase the use of technology in schools, we need to alter the pedagogical orientation of the educator toward a more child-centered view, insure that the amount of available technology for use by the faculty is adequate, and insure that the type and degree of training in the use of technology is appropriate to transfer skills to the classroom.

Administrative Concerns

While early literature on increasing technology use in schools focused on a grass-roots approach emphasizing the role of the teacher, more recent research has recognized that administrators may hold to the key to the long-range success of any technology plan (Finkel, 1990). Not only is technology usage required if administrators are to be effective instructional leaders, decision-makers, and managers (Bozeman, Raucher, & Spuck, 1991), but only when faculty see chief administrators using technology will they feel the need to learn it themselves (Barker, 1990).

In a case study of three schools in San Diego County that are successfully integrating technology and teaching, Wiburg (1991) found that common to all successful schools were strong administrators who were strong users of the technology themselves. In addition, these schools had a collaborative relationships with outside agencies, parent groups, and/or university affiliations; technology plans that called for empowering teachers to use technology; easy access to sufficient hardware and software to build a critical mass of users; and leaders who were working toward restructuring of teaching and learning in their schools. Additionally, administrative functions identified by Firestone (1989) to successfully integrate technology into the classroom included providing and selling the vision to the community and faculty; obtaining resources such as time, personnel, knowledge, materials, and facilities; providing encouragement and recognition for teachers successfully making the transition; adapting standard operating procedures which necessitate using technology; monitoring the reform effort by regularly meetings with teachers; and solving technology related problems quickly.

Given the positive and necessary relationship between administrative use and advocacy of technology, what variables seem to influence administrators to join the information age? Bloom (1991), in a recent dissertation, found that the amount of exposure and training had a direct impact. Administrators who participated in an Administrators' Technology Academy (ATA) held weekly over several months indicated that they perceived technology as being more useful in education and society than did ATA non-participants (who generally saw technology as a threat to education and society). In addition, the ATA administrators made significantly more use of computers both in the office and at home than did non-participants.

Current Training

From the previous discussions, it appears that training is a critical component in the integration of technology for both administrators and teachers. Unfortunately, technology training in education has been neglected and will probably continue to suffer with the current economic conditions. It was recently reported that only a third of all public school teachers have had ten or more hours of computer training (Business Week, 1989). Not only is this amount of time inadequate in terms of providing relevant skills and knowledge, but the majority of this time was spent on learning how to operate the machines, not on how they could be used to integrate technology into the educational process. In addition, training for administrators in the use of technology for either instruction or management is still a glaring absence in most state's administrative credential programs.

Traditionally, educational change in classroom practices have been approached through in-service training (Browne & Ritchie, 1991). Although educators often leave these training sessions energized with new knowledge, in-service training seldom has lasting effects. This occurs because these workshops often (a) focus solely on the wonders of the technology, ignore the needs of individuals involved in the change (Kinnaman, 1990), (b) lack focus on solving actual educational problems, and (c) do little to help transfer the skills to actual classroom implementation (Boe, 1989; Showers, 1990). This non-transference problem has been explored by Hord, Rutherford, Huling-Austin, and Hall, who contend

> One of the most common serious mistakes made by both the administrators and leaders of a change process is to presume that once an innovation has been introduced and initial training has been completed the intended users will put the innovation into practice. (1987, p.1).

Solutions

Trying to facilitate change in schools is not an easy task. The very structure of education—its conserving nature—is the major obstacle to change (Postman, 1979). Traditional perceptions of what teaching, learning, and knowledge should look like (i.e., lectures for delivering instruction, learning as compiling facts, and knowledge as the ability to repeat facts) are major limiting factors to integrating technology. Unless we restructure our view of education, the system will continue to stagnate.

According to Tucker (1992), restructuring schools is a necessary foundation for both enriching instruction and tapping technology. He suggests that although we know that technology can help students, mandated curriculum and its assessment hold students back.

> (T)he only way to unleash the full benefits of technology—to let the genie out of the bottle—is to radically restructure schools for high performance. We must ensure that the new curriculum these technology-based tools make possible is the curriculum that is valued by the system. We must ensure that the kind of active learning now within reach is the kind of learning that is reward by the system. (p. 50).

Not only do we need to change the way in which we view teaching, learning, and knowledge, but we must also change the way in which we train the users of the technology. The U.S. Office of Technology Assessment (1988) suggests that if technology is to take hold in schools, teachers will need to have more "how to" training, a clearer vision of what technologies are available, how the technologies should be used, and why technology can make a difference. In addition, educators need to be supported in their learning by individuals who are available and willing to serve as personal informants and troubleshooters, and to give advice and support on how to integrate technology into their curricula.

Because of the discrepancies in teachers' knowledge of educational technology and the continual enhancements of hardware and software, the California Technology Project Assessment Team suggests that staff development be an ongoing process (1991). Rather than the traditional one-shot inservice, they recommend the use of mentors at school sites to work with teachers as part of an on-the-job approach. But how can these mentors maximize their influence? One possible solution is to employ the concepts found within the cognitive apprenticeship approach to integrating technology into the classroom (Browne & Ritchie, 1991).

Instruct with Relevant, Group-Based Activities

There are at least three reasons why information received during an inservice fails to be implemented in classrooms situations. These include: (a) failure to conduct a needs analysis to identify knowledge required by users; (b) presentations limited to factual knowledge which omit higher level thinking strategies; and (c) failure to incorporate activities which are relevant to the audience in a collaborative, problem solving approach.

Although school restructuring is beginning to allow teachers a greater say in the activities of their school, most inservice topics are still dictated by a central authority, often with little regard to actual needs (Rossett, Garbosky, & Brown, 1992). Without an identification of current conditions and future expectations of the school and staff, inservice material is often too advanced, too remedial, or not applicable. Interviews and observations on the skill and knowledge level of the staff could be used to not only gain the required knowledge to help insure that training content is applicable, but also to provide the staff with the knowledge that their ideas are important.

Second, it is important that instructors focus on providing heuristics and metacognitive strategies in addition to factual knowledge. Unless the trainer is able to step away from basic knowledge and begin to include higher level thinking skills, the learner's ability to apply information to novel situations and solve problems independently will be limited (Wilson, 1991).

Third, as information is presented, activities used by the trainer should be as authentic as possible, developed within the context of their application, and presented to educators grouped into subject domains, grade levels, or administrative functions. This allows the learners to not only see the relevance of the instruction but also receive the necessary exposure to applications which can be directly incorporated into daily activities. Unless the concepts are framed in terms of the pressing problems faced by teachers and administrators, retention of the material will be low (Collis, 1988).

Model Developing Intellect

In addition to modeling how technology can be used in the educational practices, it is important to model the intellectual development needed for expert technology use. This process should include information not only on how the expert encodes and retrieves knowledge, but also on cognitive traps to expect (such as dead ends, false starts, etc.) and how to develop appropriate solutions.

Sharing knowledge on cognitive development helps the novice learner because it provides an advance organizer, which allows the users to concentrate on performance of tasks instead of worrying about mistakes; a cognitive framework to help the learner interpret feedback; an internalized guide for periods of successive approximation during practice; a social context to show that expertise is progressive; and a benchmark for measuring progress (Collins, Brown, & Newman, 1989). Novices exposed to trainers who model the progressive nature of knowledge growth often have reduced fears and develop the confidence to pursue the use of technology in their classrooms and jobs.

Coach to Accelerate Learning

The failure of in-service training is often due to a lack of follow-up meetings after the initial presentation. Coaching, define as "an observation and feedback cycle in an ongoing instructional or clinical situation" (Joyce & Showers, 1981, p. 170), has been identified as the most critical component in transferring workshop information to classroom application.

Two common coaching methods used after training include one-to-one tutoring between a novice and experienced mentor, and a cooperative group of grade-level or domain-specific educators. The purpose of coaching is to meet the needs of individual or small groups of teachers by engaging in a variety of activities to stimulate cognitive growth.

A common role for a coach is to help clarify concepts or instructional techniques which are problematic to the learner. This can be done when the coach paraphrases the information into different words, provides additional examples to help clarify the information, or reorganizes the information into relevant relationships or procedures applicable to the individual.

Coaches also provide assistance when the learner has the basic knowledge but can't quite put the pieces together. This allows the learner to come to the proper conclusions by building on their knowledge with hints and suggestions as to how a task may be solved, or by the coach completing one segment of a larger task. This process also helps novice learners develop a sense of self-esteem and confidence which often carries over into later tasks.

A further activity is for coaches to engage learners in a series of problem-solving experiences. This allows the learners a means to assess their knowledge, identify appropriate places in the curriculum to use newly acquired skills, and create strategies for implementing newly discovered knowledge.

These coaching strategies are applicable to both teacher and administrator training. During the Administrators' Technology Academy, the formation of support groups among administrators struggling to implement technology provided friends and advisors to help make decisions on purchasing hardware, software, and solving staff development problems.

This coaching processes does more than provide additional contact between the learner and the to-be-learned material. Through support, direction, and guidance, the cognitive load of the novice is lessened, which in turn accelerates the learning process and leads to quicker development of expertise.

Empower Educators

To help teachers and administrators incorporate technology integration into their long-term strategies, training must help the learner build a level of autonomy and confidence with the new material. This involves more than simply encoding the information in a cognitive form. Some strategies to help achieve this goal include fading, where the support structure provided by the coach is gradually removed; articulation, in which new learners are encouraged to verbally express their newly acquired knowledge through guided questions from a coach or in leading cooperative activities; reflection, in which learners compare their own performance to the performance of an expert to promote self-monitoring and diagnosis skills; and exploration, in which the learners are encouraged to try new tasks on their own.

These four components of instructing, modeling, coaching, and empowering within the cognitive apprenticeship approach help insure that material presented during the in-service training is transferred to actual educational activities.

Conclusions

Technology's greatest power in the long run may be the way in which its use causes teachers, administrators, and students to rethink teaching and learning. Whether technology use facilitates organizational changes in the structure of teaching and learning activities, or whether leaders open to rethinking schooling are more open to using technology, remains unanswered. However,there seems to be a relationship between schools with a high degree of technology implementation and those rethinking the process of education. In the context of a global information age where change is inevitable, restructuring education with technology has the potential to become a catalyst to help solve our educational slow down.

The incorporation of technology in school settings does not come without a price. Administrators must realize that change takes time, energy, and resources. The traditional one-shot inservice does little to help transfer knowledge to classroom practice. Such strategies as the cognitive apprenticeship approach, where relevant instruction and real-world problems are combined with continued support after the workshop, are needed to insure that the ideas and skills developed in the training are transferred to the classroom.

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A staff development model for technological change

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Introduction

A primary goal of staff development is to help educators acquire knowledge, skills, and perspectives that will improve instructional effectiveness and increase productivity through the use of more sophisticated instructional delivery systems. Within the classroom environment, teachers are expected to incorporate new technological innovations, methodologies, and ideas into practice. This growth process requires teachers to learn new technological skills and applications, explore alternative approaches to the planning and delivery of content, creatively analyze new situations, and utilize problem-solving abilities within a new context. It also challenges them to reconsider personal attitudes and beliefs held about their roles as educators and reexamine their vision of technology's place in society, schools, and their own lives. These changes in thinking and behavior require teachers, in a real sense, to be involved in the process of self-actualization. According to Maslow's theory of motivation, educators have an intrinsic need to engage themselves in this stretching process within the highest realms of personal and professional development.

Maslow's Model of the Affective Domain

Abraham Maslow (1968, 1970) developed one of the most prominent theories of motivation. Based on the perspective that human needs are the forces that prompt people's behavior, Maslow suggested that we are motivated to satisfy five categories of needs within the affective domain:

1. *Physiological needs*, including sustenance needs such as food and water, as well as needs for physical comfort.
2. *Safety and security needs*, including a sense of stability and the freedom from fear or threat of physical or psychological harm.
3. *Social needs*, or the need to feel accepted by others, receive affection, develop friendships, and be part of a group.
4. *Self-esteem needs*, including both a need for positive self-regard and a need for recognition and respect from others.
5. *Self-actualization needs*, or the desire to acquire knowledge, be creative, and reach one's fullest potential.

Maslow (1968, 1970) conceptualized these needs in a hierarchy of ascending importance, in which lower-level needs generally take precedence over higher-order needs, as shown in Figure 1. According to Maslow, a person's physiological needs would have to be satisfied before the next level of need (safety and security) could motivate behavior. Maslow asserted that only when basic needs, the lowest four needs in the hierarchy, are met can the individual become motivated by self-actualization or the need to learn, take risks, and attain the highest levels of growth. Staff development for technological change can be viewed in light of Maslow's theory, which holds strong implications for systematically assisting and responding to teachers' needs.

Maslow's Model Applied to Staff Development

Factors influencing teachers' motivation to involve themselves in higher levels of learning can be viewed within the context of Maslow's hierarchy, beginning with basic physiological needs. Research has shown that teachers' awareness and/or concern about their physical comfort within a staff development setting is foremost in their minds (Bennett, 1991). Simple measures can be taken during training sessions to increase physical comfort levels including frequent breaks, snacks and drinks, comfortable chairs, adequate heat and light, materials that are easy to read, and a varied pace of learning activities. These considerations are basic to any successful staff development program.

The second level of Maslow's hierarchy holds many implications for the design of staff development programs for technological change. Although it can reasonably be assumed that staff development activities are conducted in a setting where participants feel safe from physical harm, research indicates that teachers often do not feel psychologically safe when exploring the use of new technology (Herrmann, 1988). They describe their feelings as "apprehensive," "unsure," "scared," "nervous," "afraid," or "anxious," and are afraid of breaking something or worried about losing work. They don't trust themselves and they don't trust their machines.

Since computers and other instructional technologies are new to most teachers, many staff development participants must overcome psychological risks and pressures that often affect individuals as they venture into learning the use of new technology. The fear generally experienced and known as "computer anxiety" can be more broadly defined as "technology anxiety" to include all technological innovations. This feeling of apprehension interferes with learning as well as teachers' ability to integrate technology into classroom practice (Hunt & Bohlin, 1992).

A challenge of introducing new technology into classroom situations is to enable teachers to maintain a positive self-image and social status while assisting them in acquiring the knowledge/skills required to learn to use new technology. Any practicing professional finds it

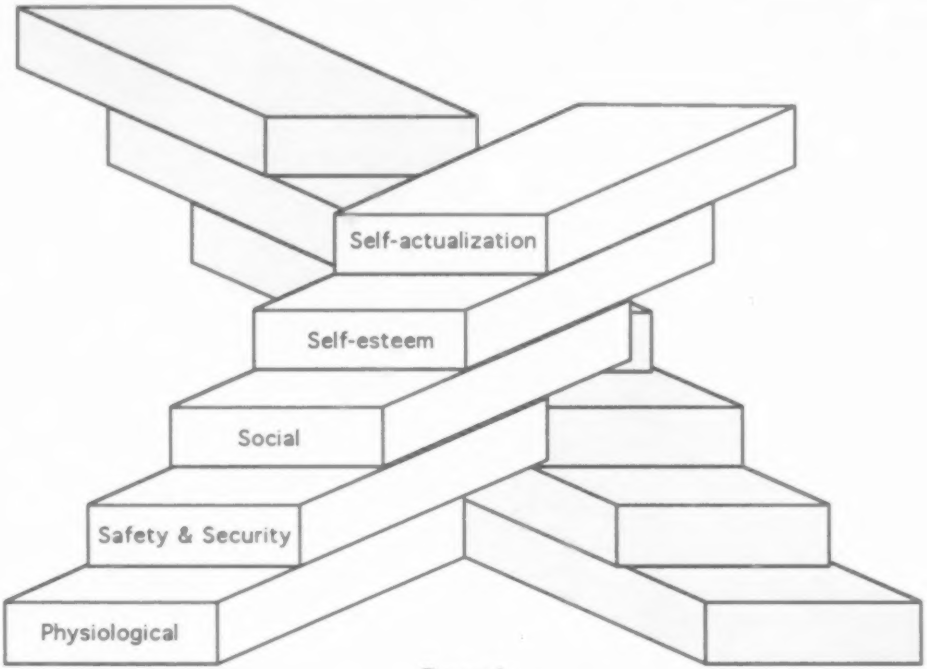

Figure 1
Maslow's Hierarchy of the Affective Domain

difficult to acknowledge they know little or nothing about technological tools, such as computers, commonly used in our society. No one likes to feel stupid or incompetent in the eyes of his or her peers and superiors, and teachers are not an exception. It is important to remember that when teachers are expected to learn to incorporate new technology into classroom practice, they move from feeling highly competent within their current teaching context to feeling not so competent as they realize they are lacking skills critical to successful teaching in the future. They must become self-actualized again within a new technological context, which steepens their uphill journey to remain current and competent. Lower elementary grade teachers may feel particularly resistant to embracing new technological devices since an overwhelming majority of those teachers are female with little cultural preparation for intimate interaction with mechanical devices.

Bloom's Model of the Cognitive Domain

Benjamin Bloom (1956) developed one of the best known systems for classifying behavior within the cognitive domain. He conceptualized a taxonomy, or hierarchy, of cognitive processes consisting of six levels:

1. *Knowledge* involves recall or recognition of specific information.
2. *Comprehension* emphasizes the understanding and organizing previously learned information.
3. *Application* requires the use of previously learned information in a new context.
4. *Analysis* refers to thinking critically about information by breaking it into parts.
5. *Synthesis* involves original and creative thinking about information by combining ideas to create a new whole.
6. *Evaluation* requires making judgments about information based on identified criteria.

Like Maslow's hierarchy of needs, Bloom's taxonomy reflects an ascending structure of classes ranging from simple to complex, as shown in Figure 2. Facts-oriented reproductive thinking provides a basis for more sophisticated, high-level productive and critical thinking. Bloom's paradigm is similar to Maslow's model in that each level of his taxonomy makes use of and builds upon the preceding classification level.

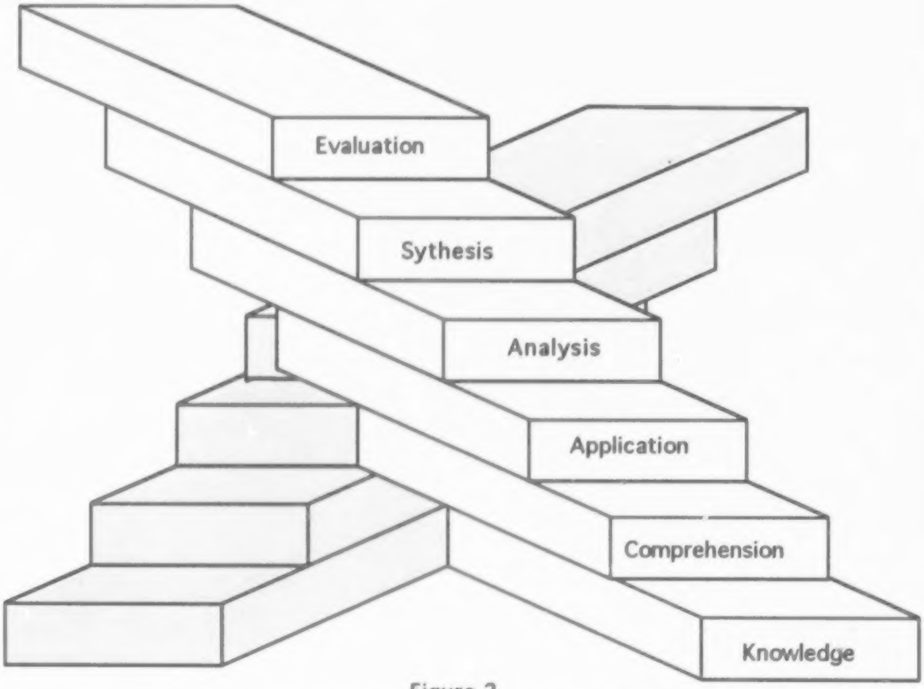

Figure 2
Bloom's Taxonomy of the Cognitive Domain

Bloom's Model Applied to Staff Development

Research has shown that half of all classroom teachers do not use computers as part of their instructional program (OTA, 1988). It is reasonable to conclude that computers are excluded from teachers' instructional practices because either they don't have the equipment or they don't know how to use it. This is probably the case as it relates to classroom use of any technological innovation.

Many staff development programs, with a goal of advancing teachers technologically, are based on faulty assumptions about how teachers learn to integrate technology into classroom practice. If we look at learning to use computers as an example, the first inaccurate assumption made is that the learning involves the mastery of only one knowledge base, or one set of skills, like learning to tie shoe laces. In fact, learning to use a computer is a complex process involving the development, understanding, application, and integration of many knowledge bases and sets of skills. An extensive, multi-faceted database must be first learned and mastered on a personal level before teachers are ready to learn how to incorporate the new technology into their teaching repertoires and teach students how to use it to aid in their own learning.

Another faulty assumption underlying the design of many staff development programs is that once a knowledge/skill base is developed, teachers will automatically be able to transfer that set of skills to a new setting without modeling, guided practice, feedback, and follow-up assistance. Without support and guidance in applying new skills, teachers feel frustration similar to that most of us experienced in school when we were expected to successfully solve a page of story problems after a week of nothing but drill and practice of facts. Learning at Bloom's lower levels does ensure a successful leap into the higher realms of the cognitive domain.

Research has shown that there is a strong interdependence between the cognitive and affective realms of professional growth as illustrated in Figure 3. Educators involved in the staff development process will feel motivated to engage in higher-level learning activities only after basic affective needs are satisfied. Therefore, staff development contexts, processes, and activities which facilitate the fulfillment of these needs will result in more energy expended by teachers to learn new skills and information (Bennett, 1991).

A Staff Development Model for Technological Change

Comprehensive reviews of the literature show that inservice teacher education is a complex system consisting of several dimensions that can influence the outcomes of staff development programs (Gall, Haisley, Baker, & Perez, 1982; Gall & Renchler, 1985; OTA, 1988). The model shown in Figure 4 groups the elements of effective staff development for technological change into three categories including technological goals and content, staff

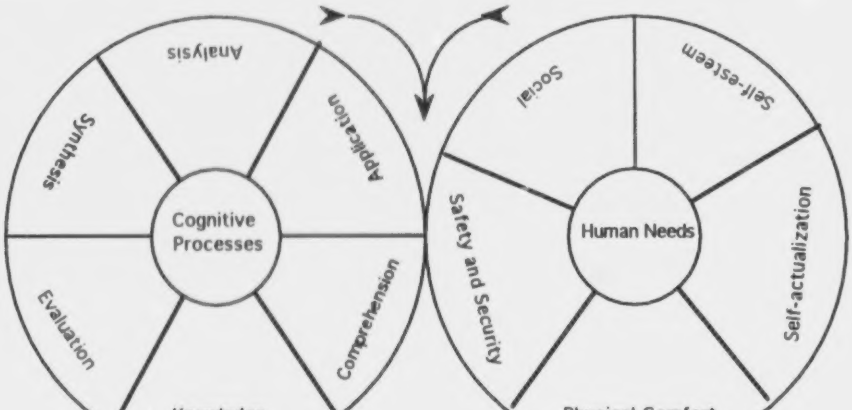

Figure 3
Interdependence Between the Cognitive and Affective Realms of the Individual

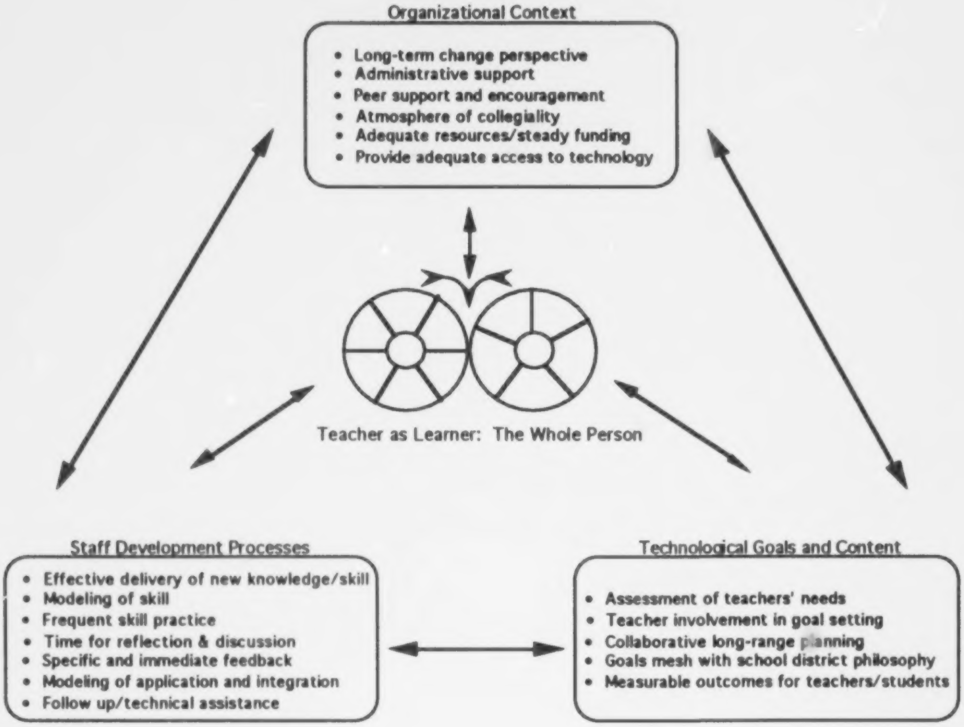
Organizational Context
Long-term change perspective
Administrative support
Peer support and encouragement
Atmosphere of collegiality
Adequate resources/steady funding
Provide adequate access to technology
Teacher as Learner: The Whole Person
Staff Development Processes
Effective delivery of new knowledge/skill
Modeling of skill
Frequent skill practice
Time for reflection & discussion
Specific and immediate feedback
Modeling of application and integration
Follow up/technical assistance
Technological Goals and Content
Assessment of teachers' needs
Teacher involvement in goal setting
Collaborative long-range planning
Goals mesh with school district philosophy
Measurable outcomes for teachers/students

Figure 4
A Staff Development Model for Technological Change

development processes, and organizational context. The teacher as learner is represented as a whole person at the center of the model. The individual's interactive internal processes (see Figure 3) influence and are influenced by an external change environment.

Organizational Context

Research suggests that the organizational context or environment of staff development efforts significantly influences the implementation of new technologies. A staff development program focused on technological change should be viewed as a long-term change effort, supported by adequate resources and steady funding over a period of time. The program should have strong administrative backing, where principals take an active role in training activities and provide teachers with the follow-up support necessary for the effective transfer of technological skills into the classroom setting. An effective program promotes the development of close, personal, and collegial working relationships among educators and allows teachers adequate access to the new technology (Jones, 1989; OTA, 1988).

Technological Goals and Content

Staff development programs are most effective when teachers are involved in the planning process (Locke, 1985). Inservice activities ought to have goals and content that are explicit, operational, and relevant to the needs of teachers, particularly those needs relating to the integration of technologies within their content areas. Additionally, staff development goals should comfortably mesh with the school district philosophy concerning technology's place in education and society. The complexity of teacher objectives and inservice content should be considered in determining the length of time needed to accomplish staff development goals. Measurable outcomes for teachers and students are important in assessing program effectiveness (OTA, 1988).

Staff Development Processes

Research offers strong support for the notion that an extensive training and implementation program is necessary to affect the integration of technology into teaching practices. Inservice activities should be diverse in nature, and include effective content delivery, modeling, practice, feedback, and follow-up support (Joyce &

Showers, 1980). Staff development programs are likely to be successful to the degree that instructors are good communicators, are or have been teachers themselves, and are able to model the skills they are teaching others (Vacca, 1983). The design and delivery of staff development activities should be based on individual differences such as preferred learning modes, learning pace, experience, and background, as well as adapted to teachers' changing needs and concerns (Knox, 1987). Also, staff development activities are most effective when spaced over time to allow teachers the opportunity to reflect upon and gradually integrate new technological skills into classroom practice (Jones, 1989; Sparks, 1983; OTA, 1988).

Conclusion

From a teacher's point of view, self-actualization means becoming the best teacher you can be through the proper use of a variety of methods within the context of teaching and learning. Staff development programs for technological change enhance teachers' quest for self-actualization as they provide teachers the opportunity to increase their productivity and creativity through the use of sophisticated technological delivery systems. Successful transfer and integration of new technological knowledge/skills into practice, however, is a complex process requiring a long-term perspective and the design of learning contexts which support teachers' cognitive and affective needs.

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A realistic approach to technology in teacher education

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Preservice teachers are graduating from accredited teacher education programs in the United States without knowing how to use a computer—whether as a word processor, to help with the calculation of grades, or to make signs and banners to decorate their classroom; let alone understand and use the computer as an instructional tool or engage in telecommunication activities. This is very wrong and it can cost them a teaching position.

In Long Island, New York and Lewiston, Idaho administrators are voicing their intent to hire teachers and administrators who have computer skills.

Long Island, NY, Superintendent of Schools, Henry P. Reed, states that his district plans to employ teachers and administrators only if they demonstrate computer literacy in word processing, spreadsheets, graphing, and data bases. Candidates who have this technical training will be hired; those who do not, face rejection (Beaver, 1992, p.2).

Steve McRae, principal at Sacajawea Junior High in Lewiston, ID, has a similar position. For this reason and others, it is imperative that all new teachers and all teachers seeking recertification be required to take a comprehensive course in educational technology.

Why aren't teacher education majors receiving instruction in computer literacy and applications? One reason is computer anxieties that interfere with the learning process (Webler, 1992).

The first computer course a person takes should teach computer basics and applications. It should be flexible and friendly because the design and expectation are crucial to student success. The beginning course will then provide a foundation to build upon with additional computer courses and applications (Webler, 1992).

SUNY College, Buffalo, NY, Study

In 1989, 300 elementary education majors at SUNY were surveyed to determine their current level of computer competence. The study was replicated in 1991. In 1989 nearly one-quarter of the students had never used a microcomputer. By 1991, the figure had dropped to 19 percent but that is still too high. Moreover, in 1991, 31 percent of the students had never used a microcomputer in any college course, and they rated their ability to use the microcomputer, as a productivity tool, either "low" or "nonexistent." The study revealed that students do recognize their deficiency and two-thirds rank learning to use a microcomputer more effectively as either "a top priority" or "very important."

University of Idaho Study

The University of Idaho is assessing the level of computer literacy of all teacher education majors. A computer literacy and usage survey was administered to students enrolled in Educational Psychology during the spring of 1992. A more detailed survey was administered to a different group of education majors in the fall of 1992. The spring survey revealed that 33.8 percent of the students had never had a computer course, and 26 percent of the graduating seniors had not had a computer course.

The fall, 1992, survey was completed by 85 education majors. Two-thirds were female. Forty-one percent were elementary education majors, forty-four percent were secondary majors, and the remainder were in special education, or preparing to teach at the post-secondary level.

Age ranged from 19 to 39 but two-thirds of the students were traditional age (19-22 years of age) meaning they have been in high school and college during the "microcomputer revolution" that has taken place during the past five to seven years. Eighty-five percent of the students were undergraduates.

Twenty-two percent of the teacher education candidates cannot type and another twenty-one percent type at less than 40 words per minute. The level of computer confidence expressed by the education majors was mixed. Although 93 percent report having the ambition to understand computers better and 68 percent reports they do not get nervous thinking about computers, thirty-three percent—one-third—report they do get nervous thinking about computers. Eighty-eight percent prefer using a computer to a typewriter but 45 percent rarely or never compose at a computer and 48 percent rarely or never pride themselves in solving computer problems.

What is Technology?

Technology is the invention of any tool that makes a task easier. The inventions of the wheel, the gasoline engine, electricity, and the computer are all technological inventions (Bartholome, 1992). Business and industry are using electronic tools in innovative but practical ways to help solve problems and improve decision-making. In education we should be doing the same.

Technology and Education

Modern technology makes individualization of instruction possible for the first time. There is no need to continue the system of grade levels or ability grouping. Teachers no longer need to teach to the middle of the class. Through technology, a mastery approach to learning is possible. Students are allowed and encouraged to learn at different paces. Students of different ages and abilities can learn independently, given the same location and time frame. Many advocate the return to community schools and the integration of students with different ages and ability levels. Nowhere in society, other than public schools, are human beings grouped together, for long periods of time, based solely on age. The goal should be the mastery of educational objectives by each student, not the promotion to the next grade every spring.

Interactive Technology

Interactive communications are under the control and pace of the user. This results in a more effective exchange of information. When microcomputers, telephones, and a modem are tied together, the amount of information and enrichment activities available, at affordable prices, is amazing. It can and should be the responsibility of every teacher in America at least to learn interactive communication and then to teach students the use of electronic technologies; to transmit, store, retrieve, and manipulate data through the use of computers and the telephone. Anymore, these tools should not be considered high-tech.

Later, student desks should be replaced with computer work stations that are networked with other students and teachers in the school, and the world at large. Computers and video cameras allow for the creation of our own instructional materials. These devices are the new pen and paper, the new chalk and eraser, the new textbook and reference materials (Frisk, 1991).

Books are heavy, become out-of-date rapidly, and can be inaccurate or misleading. How much better to examine the thoughts and ideas of a variety of authors in the real world event's context. The laser disk and interactive technologies are more flexible and can be updated frequently. An enormous amount of information can be stored on a small disc. Video and satellite transmission can bring a wide variety of teachers and guest speakers into the classroom. Resources can be tapped which are appropriate for all students including the gifted, the at-risk, and the culturally diverse.

Think Big

How might schools be different if electronic information technologies were used to deliver instruction to students through computer tutorials, simulations, guided-practice exercises, interactive videos, and hypermedia. Several basic changes would take place. Students would have many teachers who would communicate with them via the technology. Students using a computer simulation receive feedback that allows the individual student to have more control over the pace of their learning. The teacher has the time to establish a more individualized relationship with each student. The teacher is more of a student's learning experience's manager, has more time to get to know students personally and to make adjustments for their unique situations (Frick, 1991).

Hypermedia enhanced instruction provides information from multiple sources that can be searched, organized and retrieved by the user according to individual needs (Betts, 1991).

Hypermedia presentations may still be out of most public school teacher's reach but computers have already proven their effectiveness in providing students with learning opportunities that go beyond what is possible through traditional readings, lectures, discussion groups, and lab experiments. Studies have shown that when used effectively, as part of a total educational experience, computers increase student engagement, add realism to instruction, augments laboratory experiences, encourage inferential thinking, promote skill mastery and understanding of basic principles.

Can We Afford Not To?

Using a word processor, rather than a typewriter or paper and pen, is effective in improving student writing activities. In math, the computer reduces the amount of time student's number-crunch and provides more time to do sophisticated activities involving higher order thinking and learning skills. The same is true in accounting, financial management, and economics, as well as science, social science, art and music. Computers can be used to teach traditional students a foreign language and to teach foreign-speaking students English. Computers can improve reading and reduce illiteracy in older students and adults. Computers can provide students with prescriptive practice and self assessment.

Computers are no longer expensive when compared to the cost of maintaining a physical plant, busing students from place to place, paying teachers and support personnel, buying text books—which are not read nor relevant—and financing all the activities associated with sports plus extra-curricular activities.

The lag between technology and education is only going to get worse if we do not bite the bullet right now and require that all teachers be required to take a course in educational technology, those school boards and administrators work hard to get computers into the hands of students, and that teachers be required to use technology to help better address the individual needs of all students.

What Needs to be Done First

At SUNY an instructional technology course is being offered which will help education majors use technology to enhance their professional productivity. The goal will be to help students master word processing, data base management, spreadsheet manipulation, chart development, and telecommunications procedures to enhance their productivity. In addition, students will be introduced to methods of integrating these tools into classroom instruction (Beaver, 1992).

At the University of Idaho, a microcomputer applications class for teachers K-12 is being developed which will include using a computer for word processing, electronic grade books, keyboarding in the elementary schools, the merging of addresses with a letter, graphics, using a modem, how to manage a local area network (LAN), and using computer-aided-instruction (CAI).

These efforts are to be commended and will provide a computer knowledge base for all educators who take them. These courses should be required and should be made available in convenient locations for teacher in-service and professional development.

The Next Step

Although computers and telecommunications have altered the way business and industries do business, they are used far less in schools. Innovative and experimental projects are taking place but they are scattered and the picture is cloudy (Cuban, 1992).

School reformers have, and are, turning to computers and technology as a solution for motivating students, reaching students with different learning style, and providing for more prescriptive instructional experiences. The results are, at best, mixed.

Larry Cuban, 1992, professor of Education at Stanford, has identified three possible scenarios of computers and technology in public schools by the year 2,000:

1. The technophile's dream: electronic schools with computers, software, and wiring to accommodate varied groupings of students working at electronic desks.
2. The cautious optimist's scenario whereby computers in classrooms will yield a slow but steady movement toward fundamental changes in teaching and learning.
3. The preservationist's scenario whereby computers are placed in schools to reinforce traditional ways of teaching, learning, grouping, and curriculum.

Cuban asks which of these scenarios is most likely to occur in large numbers by the year 2,000. He believes that the most likely model to prevail is the cautious optimist scenario that is one of a slow, but steady, growth of computers in schools, on-going training and support for teachers, a shift from teacher-centered classrooms to students working with peers and assuming responsibility for their own learning. Schools become creative mixes of the old and the new, bringing them more in sync with society as a whole.

The optimist scenario is the most realistic and achievable. Schools move toward the 21st Century using computers and technology to gradually effect permanent and positive changes in all classes and disciplines K-12 in a sequenced, cooperative, coordinated effort.

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Integration of student learning strategies via technology

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The classroom of the future will present several different types of technologies for both teachers and students to use to facilitate student learning. At present, however, there is a striking dichotomy between technology and the classroom. On the one hand, there is a strong belief that technologies can transform student learning; the knowledge of how to use technologies, however, is often limited to specialized practitioners. At the same time, classroom teachers are being challenged to abandon traditional modes of teaching and to substitute more student-oriented, active types of learning, using alternative types of assessments. How technology fits into this revised picture of the classroom is often mysterious to teachers.

What is needed is a new type of classroom teacher, one who can combine advances in curricula knowledge and assessment with the use of technologies to facilitate these newer learning processes. This paper describes how this new teacher could be trained and outlines a demonstration program for teacher education candidates that facilitates the linking of curriculum and technology.

Teachers invariably ask simple questions of new techniques and technologies: How can these innovations help me do a better job in the classroom? How will they help facilitate student learning? Will they facilitate goals and expectations that I already have for students? On the technological side, answers to these questions are often not straightforward. New advances in computing, or communications, or multimedia applications are touted in their own right as being revolutionary, long before any evidence suggests how beneficial they might actually be in the classroom.

To produce this new type of teacher, a training program must first examine how technologies can facilitate learning in the classroom. To accomplish this goal, technologies must be categorized as to how they help promote student learning. The following section outlines a grouping of technologies from this learning perspective.

Instructional Uses of Technology

It is not very helpful to categorize technologies in their own terms: as computer based, or multimedia extensions, or telecommunications. These groupings become enmeshed in the latest technical vocabulary, which is constantly changing. What is needed is a categorization of technologies that fit instructional purposes; such a grouping should be flexible enough to accommodate changes that occur in any medium.

This section outlines four broad categories of instructional technologies: (1) Tutorial; (2) Exploratory/Problem Solving; (3) Communications; and (4) Tools/Techniques. Each category is viewed first from an instructional point of view, and then appropriate technologies that might facilitate instruction are described.

Tutorial

In their traditional role, teachers are transmitters of an accepted body of knowledge that society wants every child to know. In this sense, teachers want students to know certain content, to remember this content, and to be able to use it in appropriate situations. In an older Socratic mode, an individual teacher would tutor one student until he/she had learned the appropriate knowledge. In today's larger classrooms, teachers do their best to simulate this tutoring within the limits of time demanded by a greater number of students.

Tutorial technologies can facilitate the learning of appropriate content. These technologies include all media which attempt to provide individualized instruction for students on certain aspects of curriculum. The specific types of technologies could range from computer-aided instruction, to videotapes and videodiscs, to interactive television. Instruction could be based on a single piece of software focused on a particular subject or a networked integrated learning system which provides feedback and practice on all aspects of the K-12 curriculum. The aim of these technologies is to "tutor" on specific subject matter; usually the tutoring is very highly individualized.

Exploratory/Problem Solving

Most tutorial strategies are based on specifically defined content, with problems usually have definite "answers". Teachers often, however, want students to be able to approach and solve more difficult problems. These problems are more ill-defined and require the student to gather information on their own, evaluate this information, apply it to a problem, solve a problem, and state the reasonable criteria they used in their solution. Projects, or papers, have been the traditional focus, with lots of trips to the library.

Newer technologies can facilitate this problem solving process. These technologies which facilitate exploration and problem solving include all platforms which enable learners to access electronically large amounts of information, organize and evaluate it, and use the information to solve a problem. Technologies could include multimedia encyclopedias on CD-ROM, databases accessed through communications lines, interactive videodiscs, two-way interactive television, or a host of other technologies which facilitate the problem solving process. These technologies can help students and teachers tackle more difficult and, perhaps, more realistic problems in the classroom than ever before.

Communications

Teachers not only want students to learn specific content and to know how to solve problems. Teachers also want students to be able to communicate the results of their learning. Additionally, during the problem solving process, teachers want students to cooperate and communicate with each other.

Newer technologies facilitate the ability to communicate in many ways. These technologies include all devices which enable students, teachers, administrators, and parents to connect with each other and with learning resources that are geographically distant. Specifically, these technologies include electronic mail, data retrieval systems, networked communications, bulletin boards, two-way interactive television or even closed-circuit broadcasts within the school.

Tools/Techniques

Learning has always been aided by certain tools. Pencils and typewriters have aided the ability to communicate; an abacus, a slide rule, or a hand held calculator facilitate the solution of certain numerical problems.

The range of tools available today is both stimulating and overwhelming. Newer technologies enable students to engage in more realistic tasks and to produce more authentic products, such as papers and books, spreadsheets, hypertext, audio and video products. This range of technological tools could include word processing, desktop publishing, spreadsheet use, database manipulation, or statistical analysis. Many of these tools are essentially the same as used by business.

Technology Facilitates the Changing Classroom

Many of the educational reforms current today can be grouped into three categories, all advocating significant change in the educational process. First, there is concern over changing what is learned, with a focus on problem solving, critical thinking, and higher-order thinking skills. Secondly, the teacher-student relationship is seen as shifting from passive students to more active learners, in a classroom where collaborative learning takes place and the teacher acts like a coach. Finally, assessment is moving away from multiple choice exams that focus on isolated content to more meaningful assessments of what a student is learning, in the form of projects, portfolios, and authentic assessments.

The four categories of instructional technologies outlined above can facilitate the changing classroom in many ways. These technologies can aid teachers and students in developing a classroom that is oriented toward meaningful projects that stress problem solving skills and collaborative efforts. Additionally, more realistic products can be produced, such as desktop published books, electronic portfolios, or videos of project presentations, all of which make assessment more authentic.

The New Teacher

Once again, teacher education programs and in-service training need to be focused on training teachers who can blend newer instructional strategies with the appropriate technologies. The Institute for Educational Technologies has established a demonstration laboratory which helps teacher education candidates develop this expertise. The Institute is a consortium, represented by the Tennessee Valley Authority, the University of Tennessee at Knoxville, Carson-Newman College, and other sponsoring corporate agencies. The Institute has established a state-of-the-art demonstration laboratory at Carson-Newman College.

In this laboratory, teacher education candidates can practice conducting the classroom of the future. Technologies exist in all four instructional categories above. If a teacher wants to do a unit on middle school science problem solving, he/she has several resources: integrated learning systems which tutor students on science fundamentals; CD-ROM databases which allow students to research quickly information on a specific science problem; communications facilities which allow links to on-line services and databases; and tools, such as spreadsheets and desktop publishing, which allow the production of an authentic product.

As this scenario should indicate, the classroom of the future will demand more of prospective teachers than have classrooms of the past. Teacher education programs must forge the link between changes in curriculum and instructional strategies and advances in technologies which aid these curricular innovations. This demonstration laboratory is one such attempt to facilitate this change.

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Technology in teacher education resulting from restructuring and university initiatives

Raymond Ramquist
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Introduction

For ten years the College of Education and Psychology at James Madison University relied on teaching future teachers about technology by having each student practice on equipment and then demonstrate that skill to an examiner. In order to keep the graduates of the teacher education program at par if not ahead of practice in the K-12 environment, new forms of technology were introduced into the College's Educational Media Labs. These new forms of technology, such as interactive video and CD ROM, presented a problem of examining for proficiency without requiring inordinate amounts of time during examination. Using an approach to teaching the technology that was self-guided and relying on the merits of the software, examination time was reduced by 90%. This same approach will be used as other forms of technology are introduced into the teacher education programs at the university.

Philosophy of Technology in Teacher Education

The philosophy of the Educational Media Labs is: Involvement of the pre-service teacher with technology, software, and teaching materials is one of the keys to graduating K-12 teachers that will be productive members of the profession. To operationalize that philosophy, the College of Education and Psychology at James Madison University supports the Educational Media Labs (EML) with a staff of one full-time faculty/administrator, two full-time classified positions, and eight student positions. The EML has a yearly budget allowing it to purchase materials, software, and equipment. It serves over 800 undergraduate and graduate education students who enrolled in K-12 certification programs.

External/Internal Technology Initiatives

The EML has been in existence since 1975 but the first major emphasis on new forms of technology came in the early 1980's. *Guidelines for Educational Computing in Virginia* spelled out 13 basic computer literacy objectives and 10 computer utilization objectives that teachers in the state should achieve. At the same time James Madison University was starting to require that all students become computer literate. This emphasis on the campus was part of a plan to integrate computer literacy, global awareness, writing across the curriculum and critical thinking into every course and program at the university. In 1982 the College of Education and Psychology produced a report stating how computer literacy and computer technology would be integrated into the curriculum of the programs leading to certification in the public schools. A computer lab in the EML was equipped with 21 computers. The state of Virginia continued its plan for technology usage in public education and in 1989 published *Six Year Technology Plan for Virginia*, a plan for integrating technology in the K-12 environment. It recommended how to equip classrooms, libraries, and administrative offices, how to train for utilization of technology, and how to produce software. The commitment to technology continues as the Virginia State Department of Education is working on a new technology plan and James Madison University is creating technology classrooms, equipping every faculty member with a computer, and expanding the student computer labs by installing a specialized computer facility in the Educational Media Labs.

Technology Learning Stations

In 1975 the Educational Media Labs started with 27 equipment stations and all teacher education students learned a minimum of 12. Each learning station consisted of a set of terminal objectives, a step-by-step illustrated instruction book, the equipment, and appropriate materials. The student would learn how to operate the equipment and then either take a skill test and/or produce some end product such as a transparency. These learning stations consisted of traditional forms of technology like 16 mm, slide, filmstrip, opaque, overhead, audio, tape, and non-portable VHS recording. In the early 80's a computer technology station was added using the same format of practice and examination.

By the last 1980's, changes were taking place. In 1989, video disc and CD ROM based interactive technologies were added to the learning lab. Students coming to the EML already had operated at least one if not two computer types as a result of the university's computer literacy initiative and Virginia's K-12 computer literacy initiatives. Knowing what could be done with the equipment and software became more important than just knowing how to operate the equipment. This underlines a trend cited by Anglin (1991) that there is a movement away from hardware and toward the development and use of software. It became evident that a set of terminal objectives for operating a 16 mm projector were very different than a set of objectives for using *Compton's Multimedia Encyclopedia*. It was also apparent that having the student first learn how to use the equipment and software and then demonstrate that ability would require too much time. In learning an old form of technology the student took about 20 minutes learning and the examiner took about 4-5 minutes testing. With a computer, CD ROM, printer, and the encyclopedia software the learner would take an estimated 35 minutes to learn and the examiner and student together at least 10-12 minutes to examine. In the fall of 1991 there were 273 students using the electronic encyclopedia station. This would have taken over 40 hours of examination time.

New Approach to Teaching Technology

In 1989 a seven page learning station was introduced that used two techniques: 1) Give the learners progressively less directed help while learning and 2) Have the learners produce documentation of their learning activity. Following a series of written directions, the learner points to icons on the screen and click the mouse button. This reveals certain information that will answer a question contained in the set of written instructions. The learner then opens a notebook which is part of the encyclopedia and types in the answer. Using a highlighting technique, the learner is also directed to copy text from the encyclopedia into the open notebook. Finally, the student is asked to type into the notebook personal reactions on the encyclopedia. With this approach the average student learner completes the task in under 45 minutes. A printout of the learner's notebook from the encyclopedia is given to the examiner who takes about one minute to verify that the student has explored the encyclopedia and mastered the equipment and software. This is a saving of over 36 hours of examination time in a typical semester.

A station using the *National Gallery of Art* video disk uses the same approach while recording the learner's progress. Here the student goes around the gallery collecting paintings by making up a slide show list within the program and at the same time, answering questions about the art on a paper response sheet. A printout of the list and the response sheet are used by the examiner to verify mastery.

In two years 858, students have used the encyclopedia and 760 students have used the art video disc for respective savings in examination time of 143 hours and 124 hours. If the EML had relied on the old form of watching the student demonstrate mastery of the objectives, additional personnel hours would have been required to verify student mastery of this technology.

Restructuring of Education Presents New Needs

Effective July 1992, all James Madison University teacher education programs (except Secondary Education) were required by the state to reduce the number of education courses in their programs and none currently require a technology course. Because Secondary Education was already under the state's credit hour limit, that program did start requiring a three credit technology course in place of a values course. Some students are using interactive video disc such as *The Holy Land* and *GTV*. Students create and narrate their own video sequences and present them to their peers in either a methods or a technology class. Our challenge then is to create learning stations for all interactive video and CD ROM software.

The EML will be adding additional computers to the Equipment Learning Lab early in 1993 and these computers will allow education students to do manipulation and creation of graphics, creation of presentations, and desktop publishing. Again, the challenge will be to create learning stations that will involve the student in learning about the software while at the same time creating products that can be integrated into future K-12 teacher activities.

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Integrating technology into teacher education

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Background

As a result of the Kentucky Education Reform Act (KERA) of 1990, schools in Kentucky are restructuring through site-based management, non-graded primary schools, performance-based student assessment, and instructional uses of technology in order to change the way children are educated within the Commonwealth. KERA views technology as an important component in enlarging and enriching the learning experience of students. Thus, there was a need to develop a long range plan for the efficient and equitable use of technology at all levels. To accomplish this end, KERA created a state advisory council for educational technology with the purpose of designing and implementing a plan to cover all aspects of educational technology. While the K-12 schools have been assigned the responsibility of restructuring their programs, the higher education institutions within the Commonwealth have assumed the responsibility of preparing preservice and inservice teachers to function in the rapidly changing technological environment of both the school and society.

Since Eastern Kentucky University is the top-ranking producer of teacher educators in the state, it was important to examine the technology instruction currently offered and how the curriculum could be restructured to include all the technologies mandated by KERA. The task of preparing students to deal effectively with the demands of a technological, information-based society requires teacher education programs to be reorganized to include the technologies which are being implemented within the public schools. Under KERA, the Kentucky Educational Technology Council is developing a state wide network for voice, video, and data. This system is known as the Kentucky Educational Technology System (KETS). Technologies which are mandated by KETS include networked computer stations for students, teachers, and administrative offices; multi-media stations; telecommunications capabilities; and video production units. This statewide network is currently being considered a state-of-the-art model and has implications for other states as they develop networks.

Resources

At the end of the 1990-1991 school year, the University's College of Education had a computer lab with a variety of Apple computers with dot matrix printers. With the implementation of KERA, the need was apparent for updated technology. Aided by a grant from AT&T, the College was able to begin updating their technology. One hundred ten networkable computers, six file servers, six laser printers and six dot matrix printers were donated to the college. These computers were distributed into six computer lab settings.

One computer lab containing twenty 386SX AT&T

computers is housed in the building with the Department of Curriculum and Instruction. The computers are networked using LAN Manager software. Both a laser and a dot matrix printer are connected to the file server. Additional equipment obtained in the fall of 1992 consists of a CD-ROM player, a LCD panel for whole class projection, and an overhead projector. Application programs available on the network include DOS, Windows, WordPerfect, and Microsoft Works. In addition, education students have access to computer labs at the University's Pre-school-12 Model Laboratory School and in other locations on campus.

One of the problems which has become apparent is the need for the technologies at the University to conform to the KETS based standards. Level One standards include an Intel environment with a 386SX cpu with DOS 5.0 or the Motorola environment with a 68030 cpu with System 7. Each environment requires 4 mb of RAM, 40 mb of hard disk capacity, a network protocol of ethernet or token ring, a two button pointing device, and one parallel, one serial, and one pointing device port. File server standards for the Intel must be a minimum of 386DX while the Motorola environment must be 68030. Both the memory requirements are for 16mb whereas the Intel must have an expansion capacity to 32mb. The file server must encompass an installed disk capacity of at least 20 mb for each client station, one drive to support CD-ROM, the capacity of supporting one printer, and a 323-bit network adapter.

There are three levels of software standards: system, middle, and application software. Examples of systems software are DOS 5.0 and System 7, and Novell. An illustration of middle software, as defined by KETS, is Windows 3.1. Application software standards are designated by certain characteristics such as ease of use, ability to take advantage of color, interactivity that is multisensory, provisions for multi-lingual and bias-free use, and its capacity to be customized, supportive of relational technology, and networkable. Software that is not used through Windows may still be acceptable if it meets the other standards. Each year the KETS standards will be reevaluated and reissued to reflect trends and directions from the hardware and software developers.

Strategy

Restructuring of the College's curriculum was necessary in order to prepare undergraduates and graduates for the KETS system. Two issues of primary concern were: (a) faculty preparation and (b) student preparation.

Faculty preparation

The use of technologies and how decisions are made about technology applications in educational environments are important. An organized plan and careful, deliberate decision-making became necessary for the successful implementation of technology into the teacher education program at the undergraduate and graduate level. Concerns which had to be addressed within the Department of Curriculum and Instruction included how to define technology literacy, what control technology should have over the curriculum, types of settings in which technology should be used, what hardware, software, and related materials are needed to implement technology use, and the ethics concerning technology use both in the schools and in society.

Rather than having the technology drive the curriculum within the College of Education, a deliberate process was put into action by the Committee for Instructional Technology to guide successful implementation. The concern was that technology fulfill its promise of solving educational problems. Initially, this process called for conducting a needs assessment of the faculty in order to determine where technology could be integrated into their courses.

As a part of the plan for faculty preparation, a mini-course was designed to introduce the faculty to DOS, Windows, WordPerfect and networking. This course was not required but was available to the faculty free-of-charge under the provisions of faculty scholarships. Several of the faculty did take advantage of the course.

Building an awareness of new technologies available was necessary. Awareness of current and emerging technologies is managed through monthly faculty meetings. Each semester one meeting is devoted to demonstrating the use of various technologies such as the CD-ROM player, videodiscs, or multi-media products. These presentations focus not only on the demonstration of the hardware and software, but on how the technology can be used to meet the instructional and professional needs of the faculty. The presentations are conducted to develop a desire on the part of the faculty to use the technology as they view new innovations and to emphasize desired consequences for the use of the technology. Through this process, the faculty is kept up-to-date with the more powerful applications and how to use the technology as a tool. Consequently, some understanding of how and why to use the technology is established within the faculty.

Student preparation

Prior to KERA, some use of technology was integrated into part of the methods courses. The introduction to technology for undergraduates primarily consisted of evaluating instructional software. Software programs located in the University's Learning Resources Center were checked out by faculty for students to view for approximately one hour a semester in the Apple computer lab. In addition, undergraduates and graduate students were able to enroll in an elective course entitled *Instructional Media*. However, few education students enrolled in this course.

In 1987, a new Kentucky regulation mandated that all students in teacher certificate programs must be computer literate before enrolling in teacher education methods courses. This regulation states that computer literacy must include competency in word processing, spreadsheet, and database programs. At Eastern Kentucky University, this requirement is met either by requiring students to pass a computer application course or a written and application computer competency test. In spite of the computer literacy requirement, interviews with students indicated that they were rarely required to apply word processing, database, or spreadsheet skills in education courses. Consequently, such computer skills were seldom maintained.

Some changes have resulted from the new technology resources available and the involvement of the faculty. Some undergraduate examples follow. For example, K-4 preservice teachers in a classroom management class are linked electronically with fourth grade students at the University's laboratory school. The fourth graders maintain writing journals on the computer. The files are saved to a network directory which is then accessed by the classroom management students in their computer lab. The University students are paired with specific fourth graders and respond with comments concerning the journal writing. Examples include secondary mathematics methods students who are using the computer lab for the study of fractals and preservice teachers with an emphasis in middle schools language arts who use the program StoryWorks to create stacks of information concerning adolescent literature.

An aspect of KETS involves K-12 students actively involved with technology to produce products for their portfolios. This aspect has greatly influenced the undergraduate and graduate curriculum. In response to KERA, students at the undergraduate level are encouraged to create and maintain a portfolio within particular education classes by using available technology. The intent for creating the portfolio is to apply production ideas and techniques in carrying out classroom assignments. This portfolio is constructed by using different technologies such as CD-ROM's and online services to access information, computers to create transparencies for classroom use or visuals for learning centers, zap cameras for still images, audio cassettes for sound, and videos for motion. These varied experiences with technology consequently develop undergraduates skills in locating information and producing media.

An extension of the undergraduates' training in the application of technology is currently being investigated through the expansion of the foundations class which is taken prior to methods courses. The proposal for this class includes topics on the use of current and emerging technologies, teaching and learning theories as they relate to technology, computer ethics, and societal issues.

In contrast to the undergraduates preparation of portfolios, graduate students have an immediate need to learn about and use current technologies in response to KERA. Interviews with teachers and library science students indicate that they now believe that there is a need for knowledge about technology and its use within their classrooms. There has been an increase in the number of graduate students enrolled in Instructional Media. Students within this course are required to design and develop a proposal. The proposal requires graduate students to address the issues of how technology can facilitate the solving of instructional problems within K-12 classrooms. While the students are developing their proposals, each class period focuses on the demonstration or interaction with a different technology; for example, video, integrated software, telecommunications, hypermedia, and distance education.

Conclusion

The restructuring of the University education curriculum to reflect the use of technologies is an ongoing issue. The first hurdle to overcome is to remember that not all faculty will be convinced of the need to use technology. However, a commitment must be made by the dean and department chairperson to support programs which introduce technology applications to the faculty. Ongoing training as new technologies are introduced is vital to preparing faculty to not only use, but to integrate the technology into their classes. With adequate support, faculty believe that they will be prepared to model the use of technology within their classes. Faculty will then give assignments whereby students must apply technological skills.

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Model for creating a computer-using teacher education faculty

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Introduction and Rationale

Educational usage of computer-related technology is becoming an issue of change in K-12 schools around the country. During the 1980's, the number of microcomputers and computer terminals in U.S. schools increased over 2 million, more than a 50-fold increase, with approximately 300,000 added each of the last few years (Becker, 1991). One of the biggest problems with using computers in schools is the lack of training of the teachers who use the machines in their classroom (Becker, 1989; Carlson, 1991; OTA Report, 1988). Teachers have felt uncomfortable with the new technology, and with that lack of confidence, have not used the computers to its potential. In a 1989 survey conducted by the IBM corporation, more than one-half of the teachers felt that their students were more computer literate than the teacher himself/herself. Also, thirty-eight percent of the teachers surveyed felt that inadequate computer training was one of the obstacles to their more effective use of computers in the classroom (Nelson, Andri, & Keefe, 1991).

During the early 1980's, most attention was placed on inservice training of teachers. Veteran teachers were encouraged to "train themselves" about the techniques of using the computer effectively in their classrooms. Recently, the emphasis for training has been widened in scope to include preservice teachers. School districts are demanding teachers who are computer literate (Carlson, 1991; Johnson & Maddux, 1991). "As preservice teachers leave their teacher preparation programs, they are often faced with the realities that school districts demand they use technology, parents expect them to use it, and students want them to use it" (Novak & Berger, 1991, p. 89). Twenty-three state boards of education have enacted mandates requiring preservice teacher programs to include technology training in the curriculum (Novak & Berger, 1991).

Two organizations, the International Society for Technology in Education (ISTE), and the National Council for Accreditation of Teacher Education (NCATE), have written 12 goals for the educational computing and technology preparation of education programs that include demonstrating knowledge about computers and the effective use of computers in classrooms (Wetzel, 1992). After analyzing these goals, it is easy to understand why many preservice teacher institutions have struggled with the problems of dealing with technology in their programs. "Teacher educators are faced with a two-headed monster. They must prepare future teachers for classrooms that will undoubtedly include technology, and in order to do this, they must also prepare themselves to use technology" (Novak & Berger, 1991, p. 84).

In general, the two accepted models for infusing technology into teacher education programs usually include: 1) specific courses in technology and 2) integrating technology experiences throughout the teacher education curriculum (Wetzel, 1992). Single courses in technology have been much easier for most teacher education programs to create than the integration across the curriculum. But many authors suggest that these technology-specific courses should be an interim solution which leads the preservice teacher institutions to integrating technology in all classes (Strudler, 1991). The theme, "teachers teach the way they were taught," is the basis behind using computer-related technology as a teaching tool in all preservice teacher classes (Nelson, Andri, & Keefe, 1991; Strudler, 1991).

To facilitate technology integration in education courses, many teacher preservice institutions are trying to provide the teaching faculty with the equipment and training to use technology effectively. Three elements seem to be key in the increased use of technology. First, the equipment must be available for use (Novak & Berger, 1991). A computer on the faculty member's desk is one of the first steps in using the computer in teaching. When the computer becomes a necessary tool for the teacher, then computer use in the classroom is the next logical step. In addition, if computers are to be used for whole class purposes, a facility that will accommodate such activity is necessary.

The second element involved in teacher empowerment with technology involves training. Because of the stature of the higher education faculty member, it is often assumed that they need little training in the use of something new, in this case, computers. This seems to be untrue, and the training and subsequent support and coaching are vital if effective use of technology in higher education is going to take place (Wetzel, 1992).

Encouragement to include technology in courses is the third element of staff empowerment. Faculty members need to feel that they are being supported, as well as encouraged, to try to use and model teaching techniques that include efficient uses of technology (Nelson, Andri, & Keefe, 1991; Novak & Berger, 1991). The perception that using technology in teaching is expected, is important in the continued increase of educational technology use in teacher preservice programs.

The Model

In the Department of Curriculum and Instruction in the College of Education at Iowa State University, the use of computer-related technologies is growing rapidly. Computer-specific courses have been offered since the early 1980's, and an educational computing minor is available to undergraduate students. Also, several graduate-level classes, emphasizing the use of computers in education, have been part of the Curriculum and Instructional Technology graduate degrees. The department has included the integration of computer-related technologies in general education courses as one of the departmental goals. In order to meet this goal, the department is in the process of implementing a three-year plan aimed at providing all faculty with experiences so they can appropriately integrate computer-related technologies into their instruction. The plan contains four major elements:

1. providing computers and networking for all faculty and their classes.
2. providing voluntary workshops for all faculty.
3. providing support for answering faculty questions.
4. providing support and models for classroom integration.

Year 1 - 1991/1992

The Curriculum and Instruction Department began implementation of the plan during the 1991-92 school year. In year 1 of the project, all forty-two full time faculty members in the department were provided with a Macintosh computer and access to a local area network, a university-wide backbone network, a local mail system , and the Internet. Thus, departmental equipment money for the first year of the project was devoted to faculty computers, with the assumption that the faculty must have access to computers before they can be expected to use computers in instruction.

Following the acquisition of the computers, the workshop portion of the project was immediately implemented. The initial workshops were designed to help faculty learn to use the computers for their own work and included sessions on word processing, spreadsheets, telecommunications, campus network access, Internet uses, desktop publishing, and hypermedia. Each lunch-hour workshop lasted one hour and featured "hands-on" experiences and individual attention. The tone of the workshops was informal and supportive. The workshop facilitator, a Ph.D. student and instructor in the department, was always assisted by several graduate students who provided one-on-one support for faculty. Workshops were structured around a single topic, so that faculty could attend only sessions of their choice. Thus, faculty members were encouraged to move at their own pace using the technology and applications most important to them and their professional lives.

During the entire project, the workshop facilitator has been available to answer faculty questions and help solve problems with the hardware and software. He routinely answers faculty questions and makes "house calls" to offices to troubleshoot problems. Also, the faculty who teach the instructional technology courses encourage and support the entire faculty in their use of technology.

Year 2 - 1992/1993

In addition to workshops and individual support, the second year of the plan calls for the beginning use of computer-related technologies in general education courses. This was achieved in several ways. First, through grants, two computer-equipped classrooms have been furnished. A 20 station networked Macintosh LC II classroom, equipped with videodisc, CD-ROM, and a color LCD panel is available to faculty to use for whole-class instruction. The second facility, funded through a National Science Foundation grant, was designed to be a model math and science classroom. It includes a wide array of hardware and software, as well as math and science laboratory equipment. The goal of this project was to provide a room that would be equipped with a variety of learning and teaching tools, including computer-related technologies, all in one classroom. This classroom is used for math and science methods, as well as other education courses.

Other equipment and software are available for faculty wishing to use computer-related technologies in classrooms. Portable carts that include computers, LCD panels, CD-ROM drives, and videodisc stations, are available to faculty on a check-out basis. Also, faculty may use software from the College of Education computer lab library for classroom use.

In order to introduce faculty members and students to available software, the College of Education computer labs have developed "Software of the Week". Each week, an introductory activity is set up to use a current computer program or application. Individuals, as well as small groups, are encouraged to participate, and often, faculty and students work together in this activity. The hands-on experience is accompanied by a bulletin board, a handout, and if necessary, "people'" support from computer lab employees. The "Software of the Week" is announced at departmental meetings, and often this announcement is a time to focus on computer-related questions, concerns, or suggestions.

Year 3 - 1993/1994

The focus of the third year of the plan is integration of computer-related technologies into all courses. During this third year, it his hoped that faculty members will be comfortable enough with the computer to begin to use technology effectively in their classrooms. The department plans on providing support in several ways. A teaching assistant will be assigned the task of helping faculty integrate technology into their teaching. This person, in cooperation with the course instructor will help in the planning and development of the lessons that include technology. Also, if necessary, the teaching assistant will team teach or model lessons integrating technology. The department believes the faculty will feel the security of this "safety net" and will be less apprehensive to try new and innovative approaches to the teaching of their courses. The workshops and hardware/software support will continue, as in year 1 and 2 of the plan, but the emphasis for this third year will be placed on integration.

Summary

It should be noted that faculty participation is voluntary; the faculty, however, have agreed that integrating technology is a major departmental goal for each of the three years of the project and the department chair has encouraged faculty to include goals for integrating technology in their yearly professional goals. Thus far, faculty reaction to the project has been very positive. Typically, fifteen to twenty faculty members attend each workshop. A "computer culture" is growing among the faculty who now talk computers in the hall, share ideas for using computers in classrooms, solve problems for each other, and ask students for help in solving problems. Increasingly, faculty are using computers and computer-related technology in their teaching. Videodisc use, CD-ROM-based activities, spreadsheets for school finance and grading, simulations for classroom management activities, collaborative writing using a word processor, telecommunications, student projects using hypermedia and math problem solving software are all used increasingly in the teacher education program. By the end of Year 3, it is expected that computer-related technologies will be used as routine tools to expand and enhance each course in the teacher education curriculum. With the successful implementation of this model, students will experience effective use of educational technology and will graduate with a clear vision of how technologies can improve the learning process.

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The Roving Workstation Project: A model for improving teacher education faculty use of technology

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The infusion of technology into education has created an immense dilemma in the arena of teacher education. How can we best involve and encourage teacher education faculty to model the integration and use of technology with preservice teachers?

Currently at Gonzaga University the integration of technology into the preparation of teachers is accomplished as students complete two required courses; (1) Instructional Media, and (2) Computer Methods for the Classroom. While these courses present a broad overview of instructional strategies and methods that might be accomplished via technology, very few of the other methods or content area courses integrate technology. As a result, not only do preservice teachers fail to see instruction via technology modeled for them, they are rarely offered the opportunity to use technology for their own instruction, or as a means to practice teaching methods or strategies. Turner (1989) also describes this problem seen in a number of teacher-training institutions:

> The pressure on colleges to train teachers who can use new technology effectively is increasing from state and national sources, but few colleges of education have incorporated computers into the curriculum outside computer literacy or instructional technology courses. Experts agree computer use should extend to methods and subject courses.

In an attempt to promote the integration of technology throughout the teacher preparation program The *Roving Workstation Project* has been proposed. At the inception of this project, a number of issues were identified that have served as obstacles, preventing the faculty from taking greater advantage of the technology facilities, hardware, and software. A review of the literature revealed that in a survey conducted by the Office of Educational Research and Improvement (1989), "...the most frequently identified problems encountered in developing a computer training program were inadequate software (45%), a shortage of computer-trained faculty (42%), and inadequate hardware (34%)." In a project at the University of South Alabama (funded under the Apple Model Program for the Integration of Computers in the Preparation of Educators) designed to facilitate faculty integration of hypermedia into their curriculum, Tucker evaluated the 3-year project and found that "...the biggest need cited for skills training was time to practice". (Tucker, 1990). Additional needs identified by the education faculty at Gonzaga include uninterrupted work sessions with the hardware, a means to easily transport the technology to a traditional classroom, and an incentive that established the value and worth of their involvement and contribution to the integration of technology.

Thus, the *Roving Workstation Project* is designed to facilitate the use of technology by teacher education faculty by:

1. providing easy access to state-of-the-art technology (both hardware and software);
2. encouraging participation in the project and reinforcing the value and importance of the project by providing a stipend to participating faculty;
3. providing individual instruction and technical support to the participating faculty during the development of instructional materials.

At the foundation of these basic practices will be the purchase of three multimedia workstations that will be located on movable carts. The premise being that select faculty should have a complete workstation available for their individual use both during the development and the instructional delivery phase of the project, and that a "roving" workstation could be located in the faculty members' offices during development, and then moved directly to the classroom when the materials are used for instruction.

Procedure

The *Roving Workstation Project* will be completed in five phases, (1) Project Identification & Faculty Selection; (2) Training; (3) Development; (4) Classroom Integration; (5) Revisions and Dissemination.

Prior to the beginning of the project a *technology leader* will be identified. This individual will provide three essential services throughout the project. First, the technology leader, along with a selection committee comprised of faculty members from the Department of Educational Technology, the Department of Teacher Education, and the Department of Special Education will identify selection criteria and an application format for project proposals. The committee will then select the faculty members to participate in the project. Once faculty have been selected, the technology leader will serve as the staff development trainer during the development phase of the project. And finally, the technology leader will help to evaluate and provide feedback to the faculty as they use their instructional materials in a classroom setting.

The essential components of each of the five phases are briefly described below.

Phase 1

Project Identification & Faculty Selection-. During this phase interested faculty members will be selected based on the submission of a brief proposal identifying an area of instruction which would profit from the integration of technology. The technology leader along with the selection committee, will then select three projects, based on the predetermined criteria. The participants will then work with the technology leader to refine the project goals and create a timeline for the development of courseware, use in the classroom, and completion of revisions. It is estimated that the training and development of the instructional materials will occur in one semester and the implementation, evaluation, and revisions will occur in the second semester.

Phase 2

Training. The training phase of the *Roving Workstation Project* is critical, in that faculty will be provided with complete multimedia workstations, specifically designed to meet their individual development and presentation needs. Thus, both hardware and software will be purchased for each project, and training will be completed with each faculty member to meet individual needs. It is estimated that the training portion of the project will be conducted in one month, with 2-3 training sessions occurring each week.

Phase 3

Development.. Approximately two months will be devoted to the development of the instructional materials. During this time the technology leader will assist individual faculty members with technical problems and also serve as an design consultant. A "systems approach model" (Gagne, Briggs, & Wager, 1992) for designing instructional systems will be followed during the development phase. This approach, as presented by Gagne, is used to break the design of the project into nine stages: 1) Instructional Goals; 2) Instructional Analysis; 3) Entry Behaviors and Learner Characteristics; 4) Performance Objectives; 5) Criterion-Referenced Test Items; 6) Instructional Strategy; 7) Instructional Materials; 8) Formative Evaluation; and 9) Summative Evaluation. The first seven of these stages will be completed during the development phase of the project. Stages eight and nine will be conducted in later phases of the project. It is imperative at this phase of the project that the technology leader work closely with each faculty member, assessing the completion of each stage of development, but also serving to minimize frustration and maximize the faculty members' efforts with the technology.

Phase 4

Classroom Integration. During this phase of the project, students will be introduced to the instructional materials either through classroom demonstrations or individual work sessions. The technology leader will again serve as a consultant to the faculty member, attending class sessions when the technology is being used, or supervising students that might use the technology during individual work sessions. In this case, the technology leader will be able to provide feedback on the actually classroom situation, as well as providing technical support during instruction. Together, the faculty member and the technology leader will conduct a formative evaluation of the integration phase of the project.

Phase 5

Revisions and Dissemination. Based on formative evaluation conducted in Phase 4, revisions, either in the instructional materials or the delivery of instruction, will be completed. As revisions are finalized the projects will be shared with other School of Education faculty members and submitted for review at professional conferences.

As stated earlier, the completion of Phases 1-3 will occur in the first semester that a faculty member is involved, while Phases 4 and 5 will be conducted in the second semester. It is hoped that the project will support three new faculty members each semester for three semesters. A timeline outlining faculty participation is shown in Table 1.

The rotating schedule for Phases 1-3 and Phases 4-5 provides for the greatest number of faculty participants (approximately 18% of the School of Education faculty and 50% of the Teacher Education and Special Education faculties), and also provides an opportunity for faculty to consult each other as they move through the project.

In order to fully evaluate the success and impact of the *Roving Workstation Project*, both quantitative and qualitative data will be collected from participating faculty concerning prior instructional methods, their perceptions of student reactions and participation with past instructional methods, and students' reactions and feedback following the integration of technology in the specified instructional project.

Expected Results and Potential Outcomes

It is hoped that the *Roving Workstation Project* will enable teacher education faculty the opportunity, support, and technical assistance required to successfully integrate technology into the teacher education curriculum. Future investigations into the impact of the project on students (i.e., future teachers) will hopefully reveal an increase in use of technology as an instructional tool, as well as an improvement in the sophistication of the type of technology students use.

Proposed Budget (Approximate)

Equipment:

3	Multimedia Workstations (@ $7,500 ea)	$22,500
	Computer Workstations	$4,000
	Laserdisc Player	$1,500
	CD-ROM Player	$1,000
	Large Screen Monitor	$1,000
	Subtotal	$7,500
3	Movable Multimedia Carts (@ $400 ea)	$1,200
3	LCD Display Devices (@ $1,500 ea)	$4,500
	Computer Software (@ $1,500 per workstation)	$4,500

Personnel:

Faculty Stipends during Phase 1-3 (@ $1,000 per faculty member)	$9,000
Technology Leader (1 course equivalent per semester)	$10,000
Total	$51,700

Pilot of the *Roving Workstation Project*

Funding for the *Roving Workstation Project* has been requested and is pending final approval. However, during the spring semester of 1993, one faculty member has volunteered to pilot the project. While this participant has not gone through the proposed selection process and will

Table 1
Outline of faculty participation in the *Roving Workstation Project*

	Faculty in Phases 1-3	Faculty in Phases 4-5	Faculty Completed
Semester 1	3	0	0
Semester 2	3	3	0
Semester 3	3	3	3
Semester 4	0	3	6
Semester 5	0	0	9

not be paid the stipend, all other phases of the [illegible]oject will be carried out.

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Faculty collaboration: A critical component in applying new technology in teacher education

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Introduction

Technology is increasingly common in schools and universities as a means to create different types of learning experiences for students. Software authoring programs such as HyperCard and SuperCard for the Macintosh provide practical tools for producing technology mediated instructional materials. These software applications also offer simple mechanisms for controlling external devices such as videodisc players. In turn, the combination of computers with interactive videodiscs make it possible to produce a variety of realistic and stimulating learning environments.

Investigations into the potential uses and the effectiveness of interactive videodisc environments suggest that they may provide an excellent way to "anchor" instruction in real problem situations and thus improve student comprehension of content, problem solving abilities, and higher level thinking skills (Sherwood,Kinzer, Bransford, and Franks, 1987). As such, context rich environments can encourage the acquisition of knowledge that may be used to understand what is happening in real-life situations (Cognition and Technology Group at Vanderbilt, 1990).

The potential for information to be learned as knowledge in context rather than isolated facts to be memorized would seem to lend itself to the goals of teacher education programs. The belief in this potential led to the production of numerous interactive videodisc-based instructional materials for a teacher education program at Cleveland State University. Each program consisted of text-based background information, a teacher's lesson plan, teacher comments, references, examples of student work, and a video which may be accessed via connections in the database. Also included under the umbrella of programs were a simulation that enabled faculty to provide their classes with first-hand experience in learning how to administer an informal reading inventory, a program that enabled education students to observe and record the amount of reading and writing occurring in four content area classrooms, and a videodisc presenter utility which allowed faculty to create customized video presentations.

To introduce faculty to the benefits of instructional technology, a Videodisc Project team made presentations on technology and its potential to more than fifty faculty on a College, department, and individual basis. More than thirty faculty members attended quarterly workshops on the use of videodisc technology. Prior to the exploratory study, nine faculty members had been closely involved in the actual production of instructional materials. An additional eleven faculty members provided content expertise to the project team.

Although the Videodisc Project had been available for more than three years, the project was not meeting its potential. Its initial use centered primarily around one course. Therefore, it was determined that the key factors related to faculty members' decisions to implement the technology needed to be identified. In order to investigate these factors, a survey was conducted, using questionnaires and interviews, in which the faculty were asked about their experiences with, feelings about, and expectations of the interactive videodisc technology. Information was gathered to determine ways to improve the services provided by the Videodisc Project to the faculty, and possibly increase the use of the videodisc technology in the curriculum.

Method

Subjects

Since the Videodisc Project became available for use in the teacher education program, 24 full- and part-time faculty have taught in the core curriculum. Of those who participated in teaching these classes, only half have used the technology. Because of the exploratory nature of the study, the small population involved, and the anticipation that not all questionnaires would be returned, the sample consisted of all 24 teachers who had taught in the core. The sample included twelve full-time tenure track faculty, two full-time faculty who had moved to other universities, and ten visiting instructors. Five of the ten visiting instructors were involved in the production of instructional materials.

Survey

A questionnaire was developed in a free response format. This format was used in order to allow the respondents to indicate the reasons behind their decisions to implement the videodisc technology, rather than respond to predetermined factors. The questionnaire encouraged the faculty to respond to open-ended questions. Each questionnaire included items for those who had used the videodisc technology and for those who had not.

The survey was conducted by a faculty member who was not a member of the project staff to assure participant confidentiality. In the introductory letter, the purpose of the survey was explained. Of the 24 questionnaires sent, 15 (62.5%) were returned. Of these, eight were from faculty who had used the technology, six were from faculty who had not used the technology, and one did not complete the questionnaire. Once all questionnaires were received, the data were examined for patterns of responses in order to identify factors involved in the faculty's choice of whether or not to implement the videodisc technology.

In order to further investigate these factors, semi-structured interviews were conducted with two of the faculty who had received the questionnaire. One faculty member who used the technology, and one who does not use the technology volunteered to be interviewed.

Results

As the purpose of the study was to determine what factors were part of the decision making process, no comparisons were made between the groups of respondents who had used and those who had not used the interactive videodisc technology. Instead, the responses were examined for any patterns which might have existed in decisions of whether or not to use the technology (Copeland & de la Cruz, 1990). The patterns of responses were strikingly similar in those who used the technology and those who did not. And as a result, several factors did surface which appear to be part of the decision making process in whether or not to implement the interactive videodisc technology. (See figure 1)

Figure 1.

Advantages		Disadvantages
Content	Connects Formal Knowledge to Teaching Quality Control Over Observations Observe Teaching Strategies Observe Real Students Shared Experiences	Unaware of What Materials are Currently Available Lack of Appropriate Materials Prefer to Create Custom Materials
Technical	Control Over Content Multiple Modalities Employed Student Exposure to Technology	Time Required to Learn Technology Time Required to Plan Lessons Availability of Equipment and Labs
Administrative		Lack of Perceived Institutional Support Conflict with Other Time Commitments

One of the most salient factors across the respondents was the perception of the potential of interactive videodisc technology in a teacher education program. The value of this technology was seen in the realistic experiences it provides for students. Specifically, respondents commented on the usefulness of the technology for modeling teaching strategies and assessment techniques. "Seeing teachers actually teaching was very helpful to the students. Modeling strategies was probably the best feature," was mentioned by one respondent who had used the technology. Another respondent who had not used the interactive videodisc technology reported that its greatest potential would be, "Giving students actual samples of teaching strategies on the following: lesson development, discipline, motivation, teaching models and styles." Another respondent stated, "Actually observing some of the concepts discussed in class helps enhance learning and prepare students for implementing similar strategies." Thus, the interactive videodisc technology allows the pre-service student the opportunity to observe teachers using what they have learned in lectures and textbooks, making that information more robust.

When asked how the interactive videodisc technology provided a learning opportunity which was not met by the field visits, the two professors interviewed both mentioned that the editing feature in making the videodiscs provided a quality control not available in the field placements. But more importantly, the videodisc technology allowed one to stop the action, replay it, and thus help the pre-service students focus in on particular aspects of the learning situation. Having all pre-service students observe the same situation also encouraged greater depth in discussions. One respondent described the strength of the videodisc technology: "Actually allowing students to view ongoing classroom activities, followed by debriefing, and discussions was an asset to developing knowledge and providing scaffolding for students." The technology was seen as the way to bring the realistic models of teaching into the classroom. It also provided a shared observational experience.

Another beneficial aspect of the technology was the ability to provide variety in instructional techniques. The following statement illustrates this factor: "Most typical methods tend to involve one or two modalities (i.e., sound, discussion); videodiscs permit the incorporation of sight, sound, and discussion, thinking on the spot, and responding to educational pedagogy as it occurs." The potential benefit of using the interactive videodisc to provide variety in instruction was mentioned by those respondents who had used the interactive videodisc technology and those who had not.

All of the respondents felt that learning about technology was an important part of the pre-service teachers' education. One wrote, "This is the computer age, teachers must know the many uses of computers (instruction, word processing, drill, grading, etc.) It helps teachers and students work smarter, not harder." Many respondents stated that technology was an important part of their future, and that the interactive videodisc technology was an important way to meet that need. Their responses also indicated that most expected the pre-service teachers to use technology when they became teachers. The respondents also felt that the use of the interactive videodisc technology would be an effective way to model the importance of using technology in the classroom.

These factors are all seen as important components in the use of the interactive videodisc technology in the teacher education program. The fact that students can deepen their comprehension of the concepts, methods and strategies taught, by watching and then discussing what they have seen is very valuable. The ability to teach skills such as observation, monitoring, and evaluating is an important factor to the professors. Also, the experience of using a variety of methods in teaching was seen as essential for pre-service teachers. Given these benefits, as seen by the respondents who have used and those who have not used the technology, how could use of the interactive videodisc project be improved?

Several factors relating to problems with the use of the interactive videodisc technology were seen across a majority of the respondents. The questions asking for disadvantages of the technology and possible incentives for faculty, illuminated another common thread among all respondents—the issue of time. The time it took to learn how to use the videodisc technology was mentioned as a prohibitive factor. One respondent who used the technology stated that it was necessary to "Give up time usually devoted to presenting content to instruct students in videodisc usage." Another respondent mentioned a disadvantage of the videodisc technology, "Great deal of start-up time. Students have had to endure learning how to use videodiscs effectively by instructors."

The time to plan how to use this technology effectively was mentioned by many of the faculty who had used it as well as those who had not implemented it in their course. A respondent who had used the technology stated, "It's very time consuming to *plan* for how exactly the videodisc may fit into your course." Another respondent who had not used the technology gave one reason as, "lack of time due to time commitments of course load, advising load, research, etc."

Other problems with using the videodisc technology included the time it took for students and professors to use the technology. Time was an important factor in and of itself, but it also led to other problems. In order to implement this technology, sacrifices had to be made by some professors. One wrote, using the technology "preempts scholarly work and attention to other aspects of teaching." Another stated, "There is not enough class time to use them effectively, and when students view them outside of class they don't have the skills to work the equipment properly, and/or they don't really view them thoroughly."

Problems with time to learn to use the technology must be seen as very important to whether a professor will make the effort to implement this particular teaching strategy. Thus, in order for faculty to decide to implement the interactive videodisc technology, the issues of time to plan, revise, and learn the technology must be addressed.

Another important factor voiced by all respondents was the need for more training in how to use the interactive videodisc technology. This need was stated by respondents who had used the material and did not feel comfortable in using the technology on their own. As well, respondents felt that "actual hands-on demonstrations and practice is paramount" and that "more technical skill" was important for faculty to feel more inclined to use the technology.

Another need was to provide more inservice to the faculty about the project. As one respondent stated, "Perhaps making available information about the project and what materials you have available that could be useful." Another respondent reiterated this concern, " Schedule another round of sessions for training us on the usage and what is available." In order for faculty to use the materials they need to be aware of what is available for their use and they need to be trained in how to use the materials which are available. Only faculty who are aware of the existence of the technology and the materials appropriate for their course will make use of them.

Respondents called for more materials. As one respondent who has not used the project stated, "The emphasis has not been on my course material." It is important that the faculty recognize the appropriateness of the materials for their course if they are going to be willing to take the time to try to implement the technology in their course. One respondent who had used the materials suggested, "To have demonstrations of discs pertinent to their subject would encourage the faculty to use the equipment."

Similar to the expressed need for appropriate materials, several respondents suggested that the opportunity to be involved in developing videodiscs would be an incentive for faculty. One respondent stated that "Consultation in disc development" might provide an incentive for faculty to become involved, while another went further in stating that, "Collaborative development of discs" was necessary in order for faculty to become interested. This collaborative effort can be viewed as a way to involve the faculty, so that there would be more of a willingness to use the videodisc technology.

Administrative support was also voiced as a need for faculty to become involved. One respondent stated, "Honoring requests for administrative feedback and (at best) expression of interest would help. This teaching institution needs to care enough about the quality of instruction to support continued use and expounded use of this important technology." This need for administrative support can be seen in the limitations of time to implement innovations in courses. The fact that there are inadequate facilities for the number of students to effectively use the technology was also a problem. As well, the inconvenience of the facilities can be seen as a lack of administrative support. One of the faculty interviewed discussed the drawbacks of taking the time to plan and develop materials and then not being able to use them because of limited facilities or the difficulty in getting to the facilities in the time available for the class.

Discussion

The intent of this survey study was to discover the factors involved in faculty decisions to implement or not to implement the videodisc technology which was available through the Videodisc Project. Several suggestions on ways to improve the planning and implementation of videodisc technology were advanced based on the results. The faculty who responded to the questionnaire see the interactive videodisc materials as valuable and worthwhile in teacher education. The benefits it can provide the pre-service teachers are in a deeper understanding of pedagogy and how the information they are asked to learn in their course work is actually going to be used in the classroom.

Additionally, the interactive videodisc technology offers the opportunity to teach certain skills which would be difficult without the ability to view and discuss models of good teaching. It is seen as an excellent way to complement the experiences the pre-service students have in the field. By providing the entire class an opportunity to view a learning situation and then to discuss the various levels upon which interaction or learning is taking place, the interactive videodisc technology can help pre-service teachers understand the importance and usefulness of the material learned in their course work.

However, despite the perception of these benefits, factors which prohibit some faculty from making the effort to use the technology are considerable. Faculty require time to learn the skills involved in using technology in their classrooms. The need to feel comfortable at using new technology and methods is seen as a necessary but difficult to reach outcome of inservice programs (Copeland & de la Cruz 1990). All respondents felt the need for more professional development opportunities with the technology. The faculty who have used the videodiscs did not feel that they or their students could use it effectively without the aid of the Project staff.

However, several stated that with more training they would feel more comfortable in their abilities.

The need for more discs to address the content and focus of the different courses was also expressed. Several faculty suggested the opportunity to collaborate in making discs as one effective way to meet this need. This collaborative effort would meet two requirements; the development of more discs, and the creation of materials which address the content needs of particular courses. Collaboration would also provide the faculty with a feeling of ownership in the Project and a firsthand knowledge of how it can be specifically beneficial for them (Wideen,1987). Unfortunately, the creation of new materials requires an additional time commitment on the part of faculty who are already pressed for time.

Other suggestions made by the respondents addressed concerns they feel must be addressed by the administration rather than the Project staff. The opportunity for time to plan and develop materials would need to be provided by the administration. As well, planning the location of the courses so that lab facilities housing interactive videodisc equipment would be more readily available could only be worked out with the support of the administration. One respondent stated, "It is very inconvenient to use the technology in the classrooms assigned to us." Support from all levels of the administration is very important for the acceptance of new methods (Griffin,1987).

It would appear that in order for the interactive videodisc technology to be implemented to a greater degree, work will have to be done by faculty, the Project staff, and the administration. As one respondent stated in defining what would be a good incentive for faculty, "Start with a felt need." In other words, the faculty first need to be interested in using the interactive videodisc technology to improve their teaching. But as another stated, "Sharing of how they [interactive videodiscs] have been used successfully" by the Project staff in a professional development program would help faculty to recognize the potential of this technology. Finally, if faculty are to dedicate the time and effort needed to implement interactive videodisc technology, the administration must demonstrate an interest in promoting its use by providing time for faculty to learn and plan as well as the facilities needed to implement the technology effectively.

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New partnerships: Helping faculty integrate information technologies in the curriculum—the Learning Technologies Program

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Background

The Learning Technologies Program (LTP) was a series of workshops developed and offered by Cornell Information Technologies as a pilot project sponsored by Apple Computer, Inc., during the 1991-1992 academic year. The goal of the workshops was to help faculty who are technical neophytes to learn to use information technologies to enhance their instructional activities.

The underlying concept of the LTP was that the "instructional computing" support paradigm for faculty had to be modified. We agreed with the notion about faculty expressed recently by David Smallen (1992), Director for Information Technology Services and Institutional Research at Hamilton College: "Making the transition from being a non-user, or an occasional user, to a user in the classroom is nearly impossible unless intermediary steps are taken." The LTP was one such intermediary step.

Since the Learning Technologies Program was driven by instructional goals rather than technical ones, we started by focusing on the specific objectives of each faculty participant. Faculty participants were encouraged to set their own objectives based on some pedagogical challenge they were struggling with, however small, for which technology might offer some solution. A variety of methods was used — with an emphasis on Macintosh hands-on sessions — to offer a palette of technological solutions that would help faculty find the technology more accessible, adaptable and meaningful.

During the 1991-1992 academic year, the LTP served 224 participants from 18 states and two other countries (Canada and Turkey); they represented 43 schools, predominantly two- and four-year teaching institutions. Although the majority of participants came from the northeast, there was increased representation from elsewhere in the country as the year progressed and the LTP became more known. Half the participants were from New York State.

Faculty Participants: What They Did and What They Said

Faculty were encouraged to attend the workshop with a technical partner from the home institution. Sharing the workshop experience gave the faculty member a "private consultant," a sense of institutional support, and—perhaps most significantly—a greater chance of fulfilling his or her objectives upon the return home.

The three-day event included a variety of activities. Five non-discipline-specific hands-on sessions comprised the core curriculum: Dynamic Lecture Tools, Introduction to HyperCard, Digitizing and Images, Visual Databases (Using Videodiscs), and More About HyperCard. The sessions, created by a team of staff, were linked by workshop format and hand-out design. Specific examples were also repeated in multiple sessions to offer reinforcement and the "comfort of recognition" for newcomers to technology. It was the faculty participants who suggested that we link the five sessions.

Registration brochures invited participants to "bring their stuff," i.e., to bring the slides, photos, and other classroom treasures they had stashed away over the years—to be integrated into the outline or template solution to be started at Cornell. We came to realize that the LTP's target audience was so new to the use of technology that readers did not understand what kinds of raw materials to bring; they could not imagine the kinds of technological integration we were describing. We therefore adapted this concept into a more defined, guided "project" experience.

Once at Cornell, then, participants were offered suggestions for outlines and templates that could be created to solve the pedagogical problem they had defined in the pre-workshop questionnaire. Specified times were allotted for the partners to work together on these projects with significant consulting help available. The workshop's final session—a "show and tell" of these projects—became a favorite amongst participants. Although the projects were only "beginnings", the participants' enthusiasm and empowerment were clearly in evidence. To maintain the sense of community and follow-up on the participants' progress at home, we established a newsletter, *LTPnews*, and an on-line mail-list, *LTP-Link*.

A systematic follow-up with all 1991-1992 participants is in progress at this writing. First results emphasize three areas of growth. Faculty indicated that they had many more ideas for the possibilities that technology could offer them in instruction. They were more ready to become advocates for technology on their campuses. And, in some cases, they were willing to pursue granting opportunities to continue the work they started at Cornell.

Other participant feedback indicated that the gains were sometimes immediate and unexpected. One faculty member reported that she was able to evaluate a new software program with a far more knowledgeable and critical eye. Numerous participants commented on their loss of "technophobia". Many used the words "not intimidated any more," "shortened learning curve," and "empowered". They expressed plans to actually *do* their projects back at home—and sent their colleagues to the next LTP event.

What Have We Learned?

We have learned a great deal offering the Learning Technologies Program. First and foremost, we have a heightened appreciation for the help that faculty need to first start using technology, especially in instruction. When training faculty to use technology in instruction, the line between training and consulting becomes quite fuzzy. (Note, for instance, the tremendous value of the individual projects started by participants.) The process is labor intensive and expensive: if we begin with the assumption that faculty's role on campus does not necessarily include technology, then we recognize that helping faculty take this first step requires the dedication of quality resources.

Each LTP session included exposure to "faculty exemplars:" faculty who had successfully integrated technology into their instructional activities. Not surprisingly, participants responded enthusiastically to their own peers' demonstrations and discussions. We found the lecture-demonstration mode of including these exemplars to be consistently effective, reliable, and cost effective. This session was often followed by spontaneous discussions and brainstorming about possible uses of information technologies in instruction as well as strategies for obtaining necessary resources. Participants reported being very inspired by this component of the program.

The LTP made effective use of participants' feedback: there was an ongoing process of seeking—and responding to—the suggestions of a knowledgeable clientele. In addition, the use of professional evaluators immediately raised the quality of the LTP. Our follow-up with the first evaluators—inviting them back to offer our staff a "methods of teaching" workshop—significantly quickened the pace of the program's refinement.

Where Do We Go From Here?

The LTP seemed to touch an important nerve for faculty. The workshops quickly became oversubscribed. Participants asked permission to reproduce materials to share at home. Numerous callers requested that we travel to their schools to offer the workshops there. At the same time, it seemed more cost effective to find ways to leverage the work we had done and help others be able to offer the LTP curriculum themselves. As a result, we are offering *Train the Trainer* workshops to our counterparts during the LTP's second year.

The first *Train the Trainer* sessions are scheduled as a pre-EDUCOM Conference seminar in October, 1992, and at Cornell in January, 1993. Participants should be those who are charged with training faculty in the use of Macintosh technology—or those whose staff will be charged to do so. The program includes both pedagogical and technical issues.

We are hoping that offering an entire suite of materials and methods for integrated hands-on sessions will provide our counterparts with a significant "kick-off" to their own programs at a manageable cost. Many schools can afford to put together one or two (two-hour) sessions; four or five become too expensive without help. All *Train the Trainer* participants will receive extensive materials (hard copy and electronic: course hand-outs, demonstration files, instructor guides)—with an invitation to modify them for best use in their home institutions. We are also hoping to publish these materials for those who cannot attend any of the *Train the Trainer* sessions planned for the 1992-1993 academic year. We are considering *TTT-Link*: an on-line listserve that would help us share materials and methods with *Train the Trainer* participants.

Teaching faculty to use technology to enhance their instructional activities is labor intensive. In the current economic climate, institutions in higher education must work together to leverage these training efforts most effectively. We continue to work with the EDUCOM consortium to seek ways of sharing the materials and experience we have to offer, and welcome readers to suggest other forums for dissemination.

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A staff development project: The Model Schools Program

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George G. Bear, Director of Pupil Personnel Services, Bath County Public Schools, Warm Springs, Virginia wrote nearly nine years ago in *Educational Technology* that as far as the implementation of computer based instruction (CBI) is concerned:

> "Inservice and ongoing supervision is critical in order to overcome the two most common problems identified by teachers as limiting their expectations and sense of efficacy: (1) the lack of adequate training and (2) misunderstanding about the capabilities of computers... *Placing a microcomputer into the classrooms of teachers without inservice training was ineffective, even though consultative assistance was available.* The teachers without inservice training either never asked for assistance or became totally dependent upon it. In both cases, these teachers did not demonstrate the commitment shown by trained teachers" (1984, p. 15).

It seems that the problem of effective implementation of computer based instruction (CBI) into the curriculum is a current and ongoing situation that still demands solutions today.

Many persons, whether faculty, administrators, or students, resist change. Teachers must be encouraged to make changes that will improve their classroom performance and their institutions. It is critical in attempts to improve schooling to involve the teachers in large-scale innovations such as the use of computers. The research seems conclusive that participation in the content and development of inservice programs by teachers is vital.

Background

In 1984, recognizing that school improvement supported by technology will positively impact education, the New York State Board of Regents introduced it's *Action Plan to Improve Elementary and Secondary Education Results in New York.* To complement the Regent's plan, the State Education Department, District Superintendents and Superintendents of Schools cooperatively developed a *Statement of Strategic Direction for Computer Technology,* also in 1984. These documents provided direction over the next five years for efforts which resulted in the *Long Range Plan for Technology in Elementary and Secondary Education in New York State (1990).*

The purpose of the *Long Range Plan* is to provide direction for local, regional and state-level planning in order to apply technology more effectively to enhance the teaching/learning environment and improve school management. The four recommendations the *Long Range Plan* proposed for the Regents' approval to achieve these purposes include:

Recommendation 1

The Regents support the complete integration of technology into the teaching/learning environment of schools and the establishment of teacher and student access to telecommunications capabilities of the State-wide TNT network and other network services.

Recommendation 2

The Regents approve the development of technology systems, including the completion of the development of the State-wide TNT System, the student and financial database management applications, and connection of all school buildings throughout the State for communications, sharing and reporting purposes.

Recommendation 3

The Regents approve the development and implementation of planning procedures and support activities for complete technology integration at the local, regional and State education levels.

Recommendation 4

The Regents direct the State Education Department to develop policies and procedures for Statewide monitoring and evaluation of the implementation of the *Long Range Plan* and the tracking of technology-based efforts and expenditures in order to document their effectiveness.

The *Long Range Plan* Development Process

The *Long Range Plan for Technology in Elementary and Secondary Education in New York State* was collaboratively developed by teachers, students, superintendents of schools, district superintendents, State Education Department staff, State educational organizations and industry representatives. "As an initial step in that process, a 'Vision of the Future' paper outlining future technology applications for the educational system in 1995 was prepared and distributed to the field for extensive evaluation during June - August, 1989.

By the end of August, 1989, a total of 494 evaluations were received. The respondents reacted favorably to the overall direction for future applications presented in the 'Vision of the Future' paper. On a scale of one (strongly disagree) to ten (strongly agree), the average rating for the 'Vision of the Future' paper as a whole was 7.39". (p. 4)

Incorporating evaluators' recommendations, the draft *Long Range Plan* was developed in September, 1989 and distributed for evaluation in October, 1989 to school administrators, teachers, students, PTAs, State Education Department staff, New York State professional organizations, library systems, and strategic planners in industry.

A total of 784 evaluations were received as of early December, 1989. The respondents indicated positive agreement with each of the four major recommendations in the *Long Range Plan*. The final draft was reviewed and approved by the Department Executive Staff, the Commissioner and the Elementary, Middle and Secondary Committee of the Regents during the period of December, 1989 to March, 1990. The Regents Board gave its approval in June, 1990.

Outline of the *Long Range Plan*

The *Long Range Plan* provides for planning and implementation of the appropriate technology within all levels of New York's educational system. It addresses the following technology applications in a comprehensive manner:

Instructional Applications of technology to directly support the teaching/learning environment, such as using word processing and databases across all subjects.

Instructional Support Applications of technology to enhance the interaction between students and resources such as libraries and guidance services.

Management Applications of technology to manage human and material resources of the school, including instructional, personnel and financial applications.

Instructional Applications

Several programs were developed and implemented to integrate technology applications within the teaching/learning process. *The TNT/Distance Learning Grant Program* was offered to explore the impact of distance technology upon education and its relationship to the TNT system. *K-12 Curriculum on the Use of Computers in Schooling* is designed to address the need to integrate technology within the curriculum and write perspectives on the appropriate use of computers for each curriculum area. *Model Schools Technology Planning and Implementation Process* is a Board of Cooperative Educational Services (BOCES) shared service which helps school districts develop a comprehensive plan for instruction and instructional support applications of technology.

The Model Schools Program

Model Schools is a comprehensive staff development program for training teachers how to integrate technology effectively throughout the entire curriculum. It is the tool with which schools can provide teachers with an environment for exploring the use of technology. This program is an inter-active proactive collaboration of teachers and administrators to ensure that technology planning decisions will be made by informed personnel, that is, the facilitators and experts of instruction.

The Model Schools Program emphasizes that teachers are the critical ingredient in determining the most effective use of technology in the classroom. They will find ways to truly enhance their instruction, encourage higher levels of thinking, and prepare students for today's age of technology. An important component of the program is, therefore, encouraging and training teachers to the point that they feel totally comfortable with computer technology and its application to curriculum development.

In January, 1991, the Educational Opportunity Center (EOC) on the downtown campus of the University at Buffalo, State University of New York, formed the Computer Research and Development Committee for the purpose of researching and developing various computer initiatives to increase the effectiveness of the EOC's faculty and staff. It was given the charge to: (1) Develop long and short range computer related goals; (2) recommend hardware and software applications that can be used by faculty and staff; and (3) recommend and develop computer related inservice training modules.

During the Spring of 1991, a grant was submitted to the New York State Education Department and approved for the development of a computer lab consisting of twenty (20) IBM or compatible computers. The laboratory was initially used to conduct computer literacy courses for students, faculty and the university community. In January 1992, a grant for staff development was submitted and approved for funding under the Carl D. Perkins Vocational and Applied Technology Education Act (VATEA). Included in the grant was funding for release time, stipends for faculty and money to purchase necessary computer equipment, software, and materials.

The *Long Range Plan* includes the *Technology Planning for Improving Schools* (TPIS) process, that was adopted by the committee. TPIS employs three planning levels (Figure 1):

- Strategic planning establishes the overall direction for school and program improvement.
- Program planning translates the broad direction into plans focused on priorities for development and improvement.
- Curriculum planning specifies how technology applications are integrated into the curriculum and teaching and learning process.

The Model Schools Program and the TPIS process consists of seven major tasks (Figure 2) and are used by BOCES to provide substantial technology training services for teachers and administrators in their component school districts. The VATEA grant provided funding for an eight-member team of interdisciplinary faculty who began staff development inservice training in the summer of 1992.

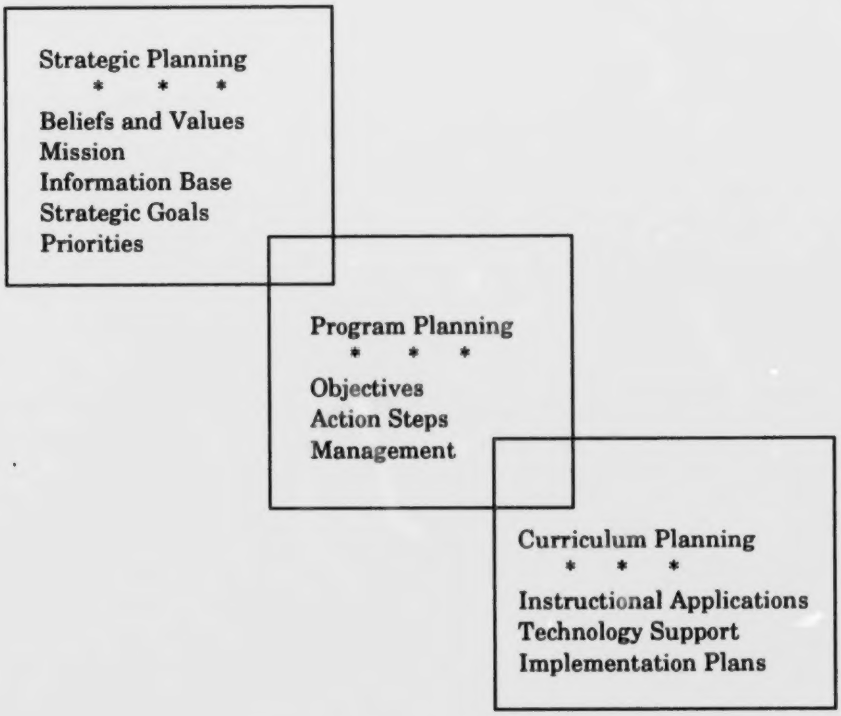

Figure 1. Planning levels.

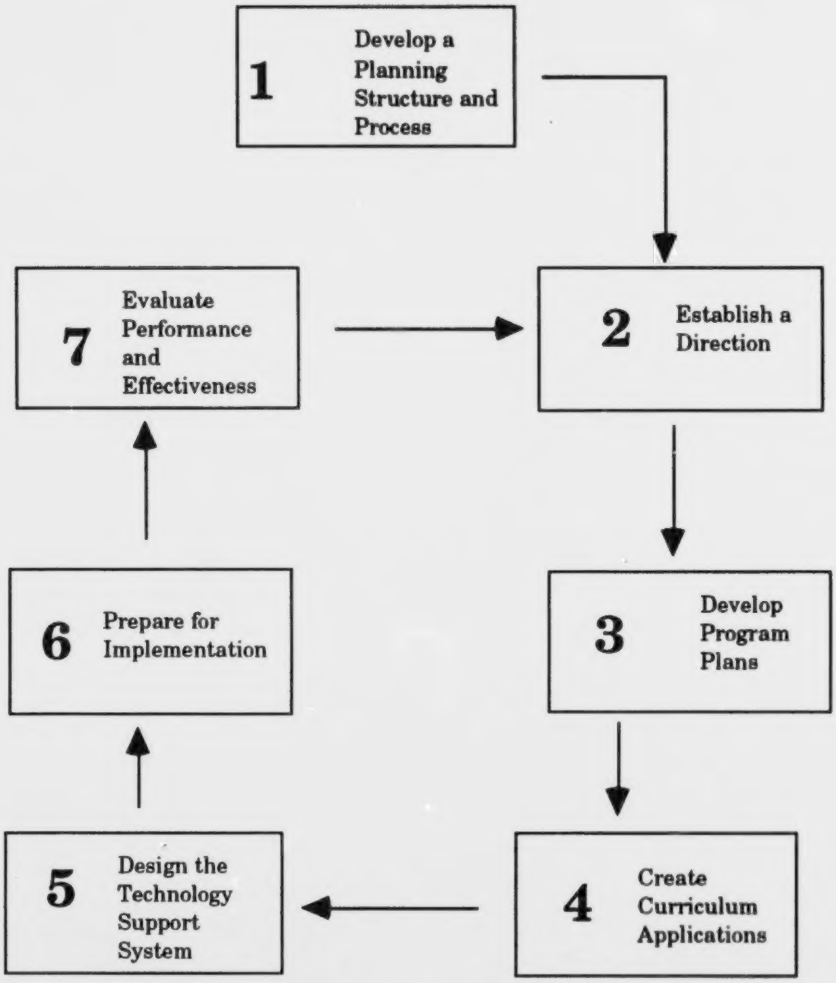
1
Develop a Planning Structure and Process
2
Establish a Direction
3
Develop Program Plans
4
Create Curriculum Applications
5
Design the Technology Support System
6
Prepare for Implementation
7
Evaluate Performance and Effectiveness

Figure 2. The TPIS planning process

Model Schools consists of five major components:

1. *Planning.* School technology teams are taught to create a comprehensive instructional plan that includes developing programs from existing resources as well as planning for subsequent growth.
2. *Staff Development.* A minimum of 15 hours of training is provided to each teacher, including the production of classroom lessons which incorporate instructional applications of technology.
3. *Technology Applications.* Teachers are trained to integrate tool software packages within instruction and to produce curriculum-based lessons incorporating instructional objectives and technology applications. Network Ties' (TNT) communications and resource services, including their participation in more than 40 Model Schools curriculum computer conferences.
5. *Program Evaluation and Demonstration.* Teachers are taught to develop and conduct a school technology evaluation process for establishing the effectiveness of their program for monitoring its future growth. Teacher demonstrations are shared for statewide replication.

The Model Schools Program has already proven to be a valuable asset to the campus and has given the EOC's staff added insight into the way technology should be integrated into our teaching environment. The three key words and involved in effecting this integration are: Incentive, Support and Responsibility.

Faculty must be given incentive (financial compensation) to become involved in the time consuming effort to achieve a competent level of computer expertise and then apply this knowledge to their disciplines.

Support must be made available to enable the professional educator to learn to use the computer and to thrive in this new environment. This support could be in the form of workshops, lectures, travel to conferences, and by having a competent mentor available to assist. In order to learn it is absolutely necessary that private and convenient access to computers be supplied.

When the incentive and support are given, it is believed that the recipient will demonstrate responsibilty for the use of the computer in the classroom.

Model Schools is making an impact on the instructional computing environment of our school and we look forward to its continuation and expansion. The administration has been extremely supportive and the faculty has responded by putting a great amount of time and effort into implementing the program. It has been pleasant learning together and we hope to include many other colleagues in this effort in the near future. The Model Schools Team is now "Computer Literate" and will become "Computer Fluent" as the program expands.

Acknowledgements

Model Schools is funded by the Carl D. Perkins Vocational and Applied Technology Act (Public Law 101-392) for Fiscal Year 1993. Postsecondary/Adult VATEA Clearinghouse, The University of the State of New York, The State Education Department.

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Q-Schools: Deming, technology and teacher education

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Introduction

This paper is about quality. It is about quality in our educational system. It is about how if educators concentrate on quality they can completely restructure the way that administrators lead, teachers teach and students learn. W. Edwards Deming's total quality management philosophy presents a working solution to the problems in teacher education and beyond. With the combination of this philosophy and technology, Quality Schools, we use the term Q-Schools, are now possible. This paper presents a brief history of Deming's life, his influence on Japan's postwar economic miracle and his philosophy. We then discuss some of his ideas about managing people and programs and how these ideas might be used in education.

Perspective

The word quality is overused by many of today's educators. We hear educators echo frequently the empty platitude that their school's mission is quality education. Likewise, the quality of teaching is often extolled as some ethereal measurement of a school's excellence. The quality of learning is absolutely and falsely measured by standardized test scores, and teaching quality is determined by state administered, multiple choice examinations. These platitudes are all too frequently used to describe today's failed schools.

Educators use quality with little understanding of its true meaning. Most of us fail to recognize that quality is a process and that the pursuit of quality is never ending. Quality comes from a profound knowledge of the system one is working in. It comes from administrators who understand that teacher education is not just a set of courses offered to meet certain pre specified and usually outdated criteria set forth by state, regional or national accrediting agencies. Quality comes from a need to serve and satisfy a customer's needs. Quality starts with the top levels of management, and permeates down to every level of an organization. It comes from teachers who understand that learning is an individual event specific to each learner. It comes from a knowledge and practice of the statistical control of variables that work in and on the system.

Quality and G. Edwards Deming

Our understanding of quality as a workable process in an organization is based upon the work of a remarkable man G. Edwards Deming. Dr. Deming, until recently, was little known in the United States. But he is revered by the people of a small island nation called Japan who have wrought an economic miracle unrivaled in the history of the world. Japan's economic miracle is due to many causes. Yet, if one were asked to identify the one most prominent cause it would be G. Edwards Deming and his ideas of quality.

G. Edwards Deming was born on October 14, 1900 in the cold winter of Wyoming. He grew up knowing the importance of hard work, the value of a dollar and the importance of knowledge. He graduated from Yale in 1928 with a Doctor of Philosophy degree in Mathematical Physics. Working on various jobs after graduation he was influenced by Walter A. Shewhart, the father of statistical control theory.

As early as 1939 Deming recognized early the value of statistics in decision making. He put these ideas to work when he accepted a job with the United States Bureau of Census as a head mathematician in statistics. His work on sampling techniques revolutionized the way the American Census was taken. Until Deming's time, the Bureau tried to gather census data by querying every citizen. Not only was this expensive, but it was also inefficient and frequently inaccurate. Deming used sampling methods that forever changed the way the Census Bureau does business. To this day, the Census Bureau is probably the most efficient branch of government in cost of operation and quality of product.

During World War II, Deming was called to work on the efficient production of war material. His work along with the work of others who believed in the validity of quality control methods provided this country with one of its mightiest weapons—the ability to design and build quality machines of war in record time. During World War II American manufacturers were able to design and bring to the battlefield high quality tanks, jeeps and even aircraft in less than six months, and in some cases in less than 90 days. Today, it takes American auto manufacturers three to four years to design, build and bring to market an automobile—a device that has not changed conceptually from the day of Henry Ford. Obviously we have gone backwards. How did this happen?

At the end of World War II, Dr. Deming's ideas were rejected by American industry and government. Deming's and Shewhart's ideas of quality and quality control were replaced by a fiscal based, bottom-line method of management that placed short-term profit ahead of quality. The rules of design, production and marketing were all derived from a fiscal viewpoint. Cost and selling price were all that mattered. As a result, quality took second place to market share and profits. In a country and world starved for goods, where just about anything would sell, quality seemed unimportant. Management became more interested in counting beans than managing production and services.

That thinking, based upon Keynesian economic philosophy and its penchant for competition, burst forth from the northeastern establishment business schools such as Harvard and Yale. Their MBA degrees became the most sought after degrees in the business world. Other business schools followed quickly. They grew at record rates pumping out thousands of graduates headed for middle and upper management jobs in industry and government. These were managers schooled in the new fiscal based ideas of production and service who, without malice, fervently believed that quality could be controlled from a fiscal perspective. The bottom-line was king and the product or service itself was of no consequence. What did matter was short term cost and profit with the assumption that quality would follow.

This quest for short term profits led to short term thinking. It inexorably led this nation to the production of shoddy goods, shoddy service and shoddy government. The decline of the American auto industry, the corruption in government and the academic bankruptcy of our schooling system are the result of fifty years of this failed fiscal policy. Where Dr. Deming's ideas lead to quality improvement and long term benefits, the MBA management ideas lead to money acquisition, quality decline and long term failure. This did not happen in Japan, however. Japanese businessmen and government officials listened to Deming, adopted his philosophy and wrought the economic miracle we see today.

Dr. Deming began his work with Japan in 1947 when he visited the worn torn nation at the bequest of the War Department and General MacArthur's occupation government. He spoke to Japanese business leaders and outlined his ideas about quality. The Japanese accepted what Dr. Deming had to offer and thus began their quest for quality and economic productivity. Dr. Deming kept returning to Japan to train and advise all levels of workers about quality. He was there in 1950, 1951, 1952, 1955 and 1956 and has returned regularly ever since. By 1950, his influence on Japanese business and industry was so important that the Japanese established what has become the most prestigious business award in the world, the Deming Prize. It is such an honor to receive the Deming Prize that companies prepare for years to compete. As of this writing, seventy Japanese companies have successfully competed for the prize since it was instituted. Only one American company has successfully competed for the prize. That company is a public utility, Florida Power & Light, which received the prize in 1989.

Deming's Philosophy

Deming believes that organizations should exist to produce products and services that make it possible for people to live better. Since this is the principle reason for organizations to exist, he stresses the importance of an institution understanding who its customers are and how to provide them with quality products and services. Following is a brief discussion of the major points, explicit and implicit, in Deming's management philosophy. We believe that if teacher educators were to embrace

Deming's concepts, colleges of teacher education could become leaders in the revitalization of American education.

Our Customer

As educators we should view the learner as our customer. Without exception, it is up to us to provide the learner with the highest quality education possible. If we are preparing teachers for America's schools, then we cannot afford to do otherwise. Anything less is fundamentally wrong. We also have other customers. Society as a whole is our customer. Governmental and business entities are also our customers in that they hire our graduates. However, to effect any positive change in our educational system by preparing better teachers, we must concentrate upon the learner as our primary customer. If we do that well, the other customers will also be served.

Adopting the New Philosophy

According to Deming (1982) adopting a new philosophy "... really means in my mind a transformation of management. Structures have been put in place in management that will have to be dismantled. They have not been suitable for two decades. They never were right ... ."

To be successful, any new philosophy of management must be adopted in total by all levels within the college. Change must be seen as benefiting all, not just the few. In professional education, Deans must view themselves as members of the faculty. The Dean, faculty and staff must all be committed to making the college work. They all must share a common vision of the future. When all members share in that vision and have a stake in the future, change will be successful. But if that vision is not shared and only a few seem to reap the rewards failure is sure to follow.

Institute Leadership

Deming believes that strong leadership is necessary for insuring quality. He stresses that leadership is the job of management. Management must recognize and take action to remove barriers for those working in the system. Management must lead with vision and compassion taking full responsibility for those in the system. Unfortunately, most managers in education do not function in this manner. They do the exact opposite of what they should do. Instead of helping workers and learners achieve, they, because of a lack of understanding of proper management, pose impediments to the design and operation of a quality system. Frequently supervisors do not understand fully what those in the system must do to accomplish their jobs. As a result, the system experiences chaos and quality is the victim. Faculty become disenchanted. Learners are cheated.

Drive out Fear

Uncertain leadership is prevalent in today's educational community. Fear, due to uncertain leadership, is commonplace in both the workplace and the classroom. The traditional style of management is built on fear and coercion. If education is to change its stripes, fear must be driven out. Deming says "Fear takes a horrible toll. Fear is all around, robbing people of their pride, hurting them, robbing them of a chance to contribute to the company. It is unbelievable what happens when you unloose fear" (Walton, 1986).

Constancy of Purpose

Deming says that management has two sets of problems: the problems of today and those of tomorrow. Traditional school management, based upon industrial age philosophies, concentrates on short term solutions at the expense of long term planning. We in teacher education cling to the old methods of teaching while espousing what the new methods should be. For example, we talk in group lectures about individualized instruction. We force new technologies into industrial age, classroom environments, and we accept the traditional university structure for course offerings. We must be activists within the university community. We must provide leadership to the school community and we must serve our customer, the learner. Teacher education must have an operational plan for the future. That plan must be the product of those who work in the system and that plan must be continuously consulted, updated and revised.

Constancy of purpose means: 1) employing innovative technologies within a proper structure to meets the needs of the learner, 2) constant and meaningful research that moves teacher education forward, 3) continuous improvement of our academic product, 4) constant attention to the needs of the learner, 5) purposeful involvement with our constituent schools, 6) continuous improvement in the working conditions and salaries of faculty, and 7) a meaningful covenant between administration and faculty pledged to a cooperative professional relationship, based upon scholarship, ethics, truth, fairness, and equitable treatment of both faculty and learners.

Continuous Improvement

Improvement of the system must be a never ending process. All who work in the system must adopt and be committed to that philosophy. If not, then failure is the result. Quality is not something added to the system as an afterthought, but a fundamental part of the system built in from the start. Thus, our product, a scholarly curriculum based upon sound research and delivered with the latest technology can truly be a quality product: A product that provides the learner with the best education possible, in an efficient manner and at a low cost.

Teamwork, collegiality, faculty governance all play a part in a Q-School. The learner must be aware that he or she is getting the highest quality product available at that time. Management must be aware that the system can always be improved and be willing to pay for the resources needed to accomplish that improvement. Faculty must be aware that they should build curriculums and technologies that are constantly evolving to higher and higher levels of quality.

Merit Systems

Deming's philosophy of management is diametrically opposed to the industrial age, postwar philosophy that has driven America's business and government organizations. As noted previously, today's management structures have been driven by profit and numbers. Quality is often spoken of, but seldom seen as the driving force behind successful operations. To the detriment of teacher education, other management philosophies have been accepted wholesale by teacher education.

Widely used in teacher education is the popular management philosophy used in industry called management-by-objectives (MBO). One of the most striking features of an MBO system is its reliance on some form of a merit system. Objectives are set and they are either met or not met. Those in the system who meet the objectives are rewarded; Those who do not are not rewarded (punished). Reward and punishment drive the system.

Merit systems encourage the cranking up of objectives as current objectives are met. The thinking goes that if workers are producing 100% of their objectives, then with a little extra effort, say 10%, more objectives can be met. This system is so appealing that all levels of management use it. It is neat, things can be counted and people can be ranked. But it is wrong.

Deming points out that "merit [systems], by whatever name, including management by objectives, are the single most destructive force in American management today" (Aguayo, 1990). Deming says that all workers in a system work as hard as they can, and unless management improves the system they cannot work any harder. Even if the workers could improve by 10%, they would more than likely be constrained by the system. The rules of the system, the management of the system, the resources allocated to the system, the time allowed to complete a task are all determined by forces outside the control of the worker.

Merit systems are inherently unfair and destroy quality. Aguayo (1990) points out that under a merit system "we are systematically destroying the people who work in the system." He goes on to say that "Our reward system destroys any possibility of teamwork by incorrectly distinguishing the above average from the below average when the difference is due to chance." Merit systems, by their nature, encourage competition and differentiation among workers. Yet they do not increase the resources or time needed to complete the job. This is a frequent complaint and one that the reader might find familiar.

Although we would like to think that teacher education is outside this description, it is not. We all work hard, we all are highly motivated, we all subscribe to a high level of scholarship and we all, more than likely, work in a system managed by an industrial age philosophy. The 10% increment is a fallacy. Merit systems must be viewed as counterproductive to any effort to improve the quality of teacher education.

Statistics

Statistical control is an important element in the Deming philosophy. When we control something, we are dealing with variation. Since variation occurs in both manmade and natural systems, all systems exhibit variation. When we are operating a system, such as a school system or college of education, we are interested in knowing whether the variation is due to chance or whether it is due to defects in the system. For example, if most of the learners in a course are not doing well we might be interested in finding out why. Our first impulse is to just fail the learner, thereby blaming the customer. If learners keep failing, we sometimes fire the professor, blaming the worker. However, if we are seeking blame we should look within the system.

We must determine which of the two kinds of variation, variation due to chance or variation due to the system itself, is to blame. Deming and his colleagues have devised certain statistical procedures to get at this problem. When chance is the cause of variation, the variation will fall between certain control limits established by measures like the standard deviation. In this case the system is said to be in statistical control. It is stable. When the variation falls outside these calculated control limits, the variation is not due to chance, but is attributed to special circumstances. This kind of variation is the signal that the system is not operating correctly and that it should be fixed. That is, the system must be fundamentally changed. According to Deming, only management can do that.

Importance

There is no more doubt about the condition of our nation's schools. American education is a failing system that needs a radical restructuring. Nowhere is the need for restructuring more needed than in our schools and colleges of teacher education.

With few exceptions, we currently educate our future teachers to function in a schooling system based upon a

19th Century industrial model. The world has transformed from the industrial age to the information age. Our teachers and administrators must be educated to function in a schooling world where contemporary ideas in computing, science, mathematics, literature, language, communication and 21st Century technologies are basic tools, not add-ons to an outdated curriculum. They must understand that the learner is the customer and not the product. Our schools must be viewed as integrated systems where information and knowledge transcend the traditional compartmentalized structures of today. Quality must be seen as a process of continual improvement through the study of variation. Deming and his ideas about quality provide us with both a philosophy and a set of tools to educate teachers to not only function in an information based society, but also to be part of the significant changes our schooling system desperately needs. Finally, it is our hope that this paper will stimulate a discussion of how to improve teacher education using the Deming philosophy. Q-Schools should be the norm, not the exception.

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The design and assessment of an inservice technology planning program

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Staying abreast of the latest technological developments, knowing how to use and apply the newer types of technology in the classroom, and planning for the school's future technology needs are important issues administrators and educators are facing today. School personnel at all levels are having difficulty keeping up with the latest developments and effectively planning their future needs. In an effort to resolve these concerns one innovative county school system in Georgia formed an educational, technology oriented partnership with a higher educational institution.

The first step in this cooperative venture was the formulation and implementation of a specially designed technology planning course for educational leaders in the school system who were instrumental in assessing and planning their school's present and future technology needs. This was followed by an evaluation of the course to determine its overall effectiveness in enhancing course participants' technology planning skills and general knowledge of the newer technologies being used in the schools today.

In examining the design and effectiveness of the course the investigator focused on four specific research questions: (1) Did the class provide participants with the knowledge and professional skills to plan and conduct a technology needs assessment?, (2) What aspects of the class were the most valuable?, (3) What aspects of the class should be changed, deleted, or added?, and (4) What types of media/technology would participants like to see more readily used in their school?

Method

Subjects

Twenty two educators voluntarily enrolled in MED 690, Planning for Technology Integration, offered spring quarter 1992. They consisted of the Superintendent, the Instructional Support Services administrative staff, and selected principals, media specialists, and lead teachers from the county's eight schools.

Course Development

To design the course to meet the county's specific technology needs, several planning sessions took place with the course instructor and the county's administrative staff. Three broad areas of instructional need were identified: familiarizing school personnel with the new and emerging technologies that are being successfully integrated into the school's curriculum, providing instruction on how to plan, implement, and evaluate a school-wide technology needs assessment, and providing guidance in the writing of the county's short and long term technology plans.

Using the expressed needs as a framework, the investigator delivered the course stressing three major content areas. These included the following: (1) an introduction to selected new and emerging types of technologies that were being successfully integrated into a number of schools within the state such as CD-ROM, videodisc players, computers, multimedia, and videotape recorders; (2) an overview of the needs assessment process, its procedures, and various applications in educational settings, and (3) an introduction to the change process and its advantages and limitations with regard to technology integration in the schools.

A variety of instructional techniques were used to deliver the course content. Course participants were given lecture demonstrations by technology experts in the state on a number of innovative, educational technologies; taken on tours to selected model technology sites in Georgia at the junior high, high school, and college levels; and taken to a state technology conference where participants were allowed to attend sessions of their choice. In addition, course participants were required to conduct a school-wide technology survey and make a report to the class summarizing their findings. Such information as the school's goal in technology planning, the planning activities that took place within each school during the needs assessment process, how the survey was implemented and analyzed, and each school's present and future technology needs were presented. One week before the presentations were made the instructor met with representatives from each school to critique the final reports.

Course Assessment

At the end of the ten week course participants completed a questionnaire that examined both the effectiveness of the course and its contents. Open-ended questions collected information on the nature of the course and closed-ended questions were used to collect demographic information on the course participants.

Analysis

A content analysis was conducted on the open-ended questions. Frequencies for each response were tabulated and rank ordered from the highest to the lowest frequencies. To check on content reliability two reliability checks were carried out: a reliability check to determine if there was evidence for each statement and a reliability check on the two raters to determine if there was interrater agreement. Both checks supported the study's findings.

Frequency counts were tabulated for each closed-ended question and then converted into percentages to provide an overview of the background of course participants.

Results

All of the twenty-two participants completed the questionnaire. Twenty-one of the respondents (95.5%) reported the course was effective in providing them with the knowledge and professional skills to plan and conduct a technology needs assessment. One respondent, however, had no response to the question.

The four aspects of the course that were identified as the most valuable were: (1) visiting model technology sites in the state and getting an opportunity to observe some of the newer technologies used in school systems (91%), (2) receiving information on some of the newer technologies being used for instruction (45.5%), (3) planning and implementing a school-wide needs assessment for the following year (36.4%), and (4) being introduced to the needs assessment process and having a framework in which to conduct a technology needs assessment (13.6%).

Fourteen suggestions, ranging from one to three in frequency of response, were made by the course participants with regard to aspects of the course that should be changed, deleted, or added. The top four suggested course modifications were: (1) offer the course at another time of the year, not spring quarter (13.6%), (2) delete some of the less technology oriented items from the school technology needs assessment such as textbooks and the chalkboard (9.1%), (3) add a school visitation to an elementary school (9.1%), and (4) provide more hands on technology learning experiences for class participants (9.1%).

Nine types of technology were identified by the respondents as those they would like to see added to their school's technology or more readily used in the schools. The top five types of technology were: (1) CD-ROM (68.2%); (2) computers (50.0%); (3) videodisc player (36.4%); (4) television with CNN (31.9%); and (5) satellite communication, multimedia, and videotape recorders (13.6%).

The demographic portion of the survey found that the majority of the course participants were administrators (68.2%), at the early childhood school level (40.9%), between the ages of 40 and 49 (59.1%), had either 11-15 years or 21 or more years of experience in education (31.8%), had a specialist degree (45.5%), and were in a rural school setting (81.8%).

Discussion

This study found the delivery of a technology planning course an effective means of providing educational leaders with the professional skills and knowledge to successfully plan for their present and future technology needs. Based on these findings the investigator strongly recommends that more schools consider forming partnerships with higher educational institutions to keep up with the latest technological developments. Secondly, the investigator suggests that technology trainers consider using the study's instructional content and activities as a framework in designing and delivering technology planning courses to practitioners in the field.

In light of the small sampling of participants involved in the technology class and resultant study, the investigator recommends that further research be conducted. This could involve replicating the present technology class and study using a larger population or designing, implementing, and assessing a technology class focused on another aspect of technology such as the training needs of teachers in the schools. Additional research would increase the reliability of these exploratory findings.

Credits

The technology planning class and research study were made possible through a series of grants from the Regional Center for Teacher Education at West Georgia College, 1991-1993.

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Preparing teacher leaders and change agents for technology in education

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Background

Research on educational change strongly supports the notion that innovations will not be implemented in schools merely because they make sense and meet specified needs (Fullan, 1991). Fullan cites a "huge negative legacy of failed reform" (p. 354) and states that a complex web of factors must be present to support innovations. Technology-based innovations in schools, though possessing unprecedented power and potential, have thus far conformed to the negative legacy of previous reform efforts. Impediments that limit the effectiveness of technology use in schools include inadequate resources, lack of teacher preparation and staff development, lack of planning time, and inadequate on-site support (Braun, 1990; Sheingold & Hadley,1990; Strudler & Gall, 1988; U.S. Congress, 1988).

The prospects for effective use of educational technology, however, should be viewed with at least some optimism. Broad experimentation over the past decade has resulted in the application of many innovative methods and programs (U.S. Congress, 1988). Furthermore, there is evidence that teachers in a coordinating role can perform a variety of functions that help schools overcome many of the existing impediments to effective technology use (Bruder, 1990; Strudler, 1991; Strudler & Gall, 1988). With the increasing number of teachers serving such roles, however, the professional development needs of teacher leaders is greater than ever (Fullan 1990, 1991). Studies that have focused on computer coordinators (Strudler, 1991; Strudler & Gall, 1988) and other staff developers (Miles, Saxl, & Lieberman, 1988) support this notion and suggest that professional development opportunities be made available for teacher leaders charged with facilitating change.

Action Research as a Professional Practice Strategy

One strategy for enhancing teacher leadership and for helping teachers become change agents in schools is action research which focuses on site-based problems of immediate concern (Glesne, 1991; Kemmis & McTaggart, 1982; Noffke, 1992; Noffke & Brennan, 1991; Zeichner, 1987). It also is geared toward finding solutions to practical problems (McKernan, 1988) and toward linking theory with practice (Hunt, 1987). Therefore, when doing action research, teachers usually select problems for study that are directly related to their practice, thus helping them develop an informed framework for making decisions, and develop a basis for making effective changes in practice.

Studies suggest that action research helps teachers sharpen awareness of teaching problems and improve problem solving skills (Noffke, 1992; Glesne, 1991; Zeichner, 1987). While findings such as these support the promise action research holds for fostering the professional development of teachers as instructional leaders and change agents for technology use in schools, how best to employ action research to achieve these ends is unclear. Systematic studies are therefore needed to help teacher educators gain insight into staff development activities that build such skills.

Purpose and Research Questions

The primary purpose of this study was to explore how action research as a model for professional development (Allen, Combs, Hendricks, Nash, & Wilson, 1988; Noffke, 1992) helped one cohort of teachers gain insight into the process of school change, and provided them with opportunities to facilitate change in specific school contexts. Given the need to examine strategies that foster the professional development of technology coordinators (Strudler, 1991; Strudler & Gall, 1988), this study asked three questions.

1. How does action research influence teachers' ability to facilitate technology-based change in schools, if at all?
2. How does action research influence teachers' awareness of problems related to technology in education?
3. What personal and professional meaning (i.e., rewards, frustrations) do teachers derive from participating in action research?

Participants

The participants in this study were a cohort of ten teachers enrolled in a computer education course designed to help students study the change process in schools. All participants were experienced teachers and some were computer coordinators. All teachers had experience working with computers, although some teachers had more computer expertise than others.

Overview of the Course

The computer education course, titled "Computer-based Technology and Educational Change" is required for all students seeking a masters degree in educational computing and technology at the University of Nevada, Las Vegas. The course provides an overview of issues and trends pertaining to the implementation of computer-based innovations in schools. Topics for the course include staff development, research-based strategies for technology coordinators, grant writing, and long range planning for effective change.

A key component of the course is an action research project. Using the five-phase model of action research model described below, teachers in this study were asked to conduct research that focused on the change process involved with implementing technology at their schools. The model was based on the action research process described by Kemmis & McTaggart (1982) and on the cognitive development model suggested by Neisser (1976). Hence, the study was grounded in a conceptual framework of action research and of cognitive psychology.

The first phase of the action research was called description and speculation. This phase was intended to help teachers pinpoint a problem for conducting their action research project. To begin phase one teachers asked themselves open ended questions, what Spradley (1979) calls grand tour questions. For example, they asked, "What is happening here?" "What problems are most salient about my teaching context?" "What might happen if something is changed in the context?"

After teachers developed a research focus, they began the second, or exploration phase. Questions included, "How will I find out more about the problems I've identified?" "What process will I use to explore the problems?" Phase three, or the discovery phase, occurred both during and after data collection. This phase helped teachers to reflect on their research, and to consider its implications for practice. Questions for this phase were, "What have I learned from this inquiry?" "How can I share with others what I have learned from this inquiry?"

The fourth phase was called reflection and modification. To begin this phase teachers asked, "How have my perspectives/views changed because of my action research exploration?" "What are the implications of my findings for the classroom learning environment?" For the final phase, teachers returned to the description and speculation component of the action research model. They questioned, "Given what I've found in this research project, what do we need to know more about?" "What additional questions can I now ask about my original problem?" These questions helped them conclude the current research while serving as the beginning phase for the next project.

Participants in the class received feedback on their projects during regularly scheduled, small group discussions. These discussions provided teachers with an ongoing forum to discuss their perceptions and findings, as well as to get suggestions and support from their peers.

Data Collection

Using the case study method suggested by Yin (1989), multiple sources of data were collected for each teacher. Data sources were personal journals maintained by the teachers throughout their action research projects, our observations of small group discussions, and formal reports of the action research projects. Teachers maintained field notes of their research in personal journals, recording their thoughts, perceptions, and insights. They were encouraged to review their field notes regularly and develop theoretical memos (Strauss, 1987). Developing these memos required deliberate, reflective thinking about the action research projects and about the relationship between theory (i.e., course readings) and practice (i.e., real efforts to use technology in schools). As a data source, the personal journals were reviewed both during and after the course.

Data Analysis

Using the constant comparative method (Strauss, 1987), data analysis began as data were first collected and continued throughout the study. Field notes were examined in an open fashion, searching for how teachers interacted with their action research projects, and for salient themes describing how action research influenced teachers individually and collectively.

Consistent with qualitative data reporting (Strauss, 1987), the results below, which include four salient phenomelogical themes that describe how action research influenced teachers' professional lives, include teachers' own voices and our holistic impressions. The emerging themes identified were problem framing, managing and preparing for change, recognizing impediments to change, and enhancing professional knowledge. While data from all teachers were used in the analysis, the themes are discussed below through a cross-case analysis of Jan and Barbara, thus illuminating differences in how action research influenced two teachers.

Jan

Jan has been a primary teacher for 15 years. Her initial involvement with computers occurred in 1986 when her principal asked if she would like to attend a district training session for computer resource teachers. At that time she had no experience with computers but was very willing to learn. Subsequently, Jan began using computers in her own teaching and began conducting inservice workshops for other teachers in the district.

In August 1991, Jan moved to a brand new school that was committed to implementing multiple innovations including multi-age groupings, restructured decision-making, and integration of technology. Her action research project focused on her faculty's use of a newly installed networked computer lab that became operational in January 1992. Specifically, Jan wanted to explore whether the staff's confidence and use of the computers would increase if her time and expertise were made more available to teachers in her school?

Barbara

Barbara has been an elementary music specialist for six years. First introduced to computers in the fall of 1990, she proceeded to learn about computer applications in schools at a rapid pace. She "didn't really notice the lack of technology" in her school until her interest emerged, after which she attempted to share her "discoveries" with faculty members by conducting some inservices after school. The attendance, in her view, "was dismally low" and she felt "quite disillusioned" with her efforts.

The following year, in the spring of 1992, Barbara was interested in further exploring the use of computers with her faculty as part of her action research project. She focused on learning more about the attitudes and beliefs of her staff. How would they use a computer if they had access to one? How would teachers feel about using a computer for whole-class instruction? What would they think of having a school-based computer resource person to help them use computers with students?

Results

Problem Framing

As teachers conducted their action research projects and as they reflected on their projects in personal journals, they demonstrated an ability to recognize perplexing situations; that is to identify and frame problems. We gave the name, *problem framing*, to this phenomenon. Two types of *problem framing* were observed: *direct* and *indirect*. *Direct problem framing*, which we viewed as a primary function of the description and speculation phase of action research, occurred as teachers identified their initial problems. The *direct problem framing* demonstrated by both Jan and Barbara was linked to their perceptions of self as computer specialists, to their felt need to help other teachers, and to conditions in the school context. For example, Jan wrote about the initial phase of the model,

> One of the questions I wanted to answer was: If my time and expertise were more available, would it increase teacher confidence and use of computers? I wanted to provide a comfort zone, a safety net for teachers who needed it and to be of best assistance in the use of the new lab.

Barbara's initial *problem framing* focused on helping teachers gain information that would help them construct a fuller understanding of school computing. Barbara noted in her action research report,

> In looking at my staff this year I wanted to find a new angle to reach them. A new way of looking at the computer. I wanted to know how I could help them to see the computer as a tool for classroom use rather than a toy or cheap arcade room.

As Jan and Barbara began their action research projects with these initial problems, they began demonstrating the second type of *problem framing* we observed, called *indirect problem framing*. With indirect framing Jan and Barbara refined their original questions and they began developing insights for framing additional problems. Jan, for example, noted a concern in her personal journal about teachers' use of the computer lab: "I have a concern that some teachers are going into the lab with students before they have spent enough time familiarizing themselves with the lab and the programs." Barbara voiced a similar concern after observing a fifth grade class in the computer lab and talking with the class' teacher.

> I asked the teacher if she carried any of the teaching suggestions into the classroom. She said that she didn't know that there were other activities but she wouldn't use them anyway. There is absolutely no connection between the computer lab and classroom learning.

Concerns like these developed during action research gave Jan and Barbara a schema for framing secondary problems about computers in education, and provided additional insight into the dynamics of facilitating change relative to computer technology. As a consequence of the action research project and as a function of *direct* and *indirect problem framing*, Jan and Barbara recognized perplexing situations about the use of computers in their schools, and began considering action plans for changing these situations.

Managing and Preparing for Change

Managing and preparing for change involved coordinating activities and actions that enable educators to consider ways for integrating computer technology into classroom instruction. In a sense, *managing and preparing for change* can be likened to preparing a field for planting. Much needs to be done to establish "fertile soil" that will support growth. This might involve developing seminars and workshops for faculty, encouraging teachers to use computers in their classrooms, visiting classrooms where computers are being used, or establishing dialog among the faculty concerning the use of technology. *Managing and preparing* involves the preparatory thinking and related actions that may lead to change.

In Jan's case we observed efforts to structure teachers' initial experience with the network (i.e., get them on-line and familiar with what programs are available), devise a schedule for teachers to bring students into the lab, and plan inservice workshops for further staff development. She sent a memo to all teachers on the steps for using the computer lab with students and surveyed teachers' attitudes about the lab. Based on this survey, Jan learned which teachers were not comfortable in using the lab and she worked closely with them and their students.

In a sense, much of Jan's work in *managing and preparing* involved establishing an "informational infrastructure" and "getting things rolling". Moreover, her journal shows thought and action in preparation for future developments. Jan collaborated with her principal in planning to acquire additional computer resources. She wrote,

> We are looking at ways to get money for computers and other technology (modem, laserdisc, scanner, CD-ROM). Our vision would put computers in every classroom and network them into the lab. We are also hoping to participate in a pilot program to develop global education through the use of telecommunications. Our goals are big....

Barbara's action research also included surveying the faculty about their current use of computers as well as their ideas for future use. Primarily, Barbara's preparatory work focused on gathering information that could lead to increased computer use. Toward the end of her project, however, Barbara got the opportunity to demonstrate a simulation in an effort to expose the faculty to possibilities beyond drill and practice software and "plant seeds" for future growth. She wrote,

> What a wonderful experience! I demonstrated Tom Snyder's Decisions, Decisions today with room 51. The teacher stayed for 30 minutes longer than she was going to, the principal came in to see the demonstration, and both of them loved it. The kids loved it!...I loved it [too]!

Recognizing Impediments to Change

Recognizing impediments to change involved a teacher's instinct to "read" the constraining forces that serve as impediments and to subsequently apply this knowledge to overcome such forces. As stated previously, institutional obstacles such as inadequate resources, lack of staff development, lack of planning time, and inadequate on-site support have been well-documented. Furthermore, research suggests that the personal dimension of those implementing change is often of more critical importance to the success or failure of the change effort than is the technological dimension (Hall & Loucks, 1978).

Jan's action research pointed to one overarching impediment: the limited time and energy that teachers face as they work in a new school committed to implementing innovative teaching methods. She observed,

> Many teachers had expressed an eagerness to take their students into the lab, but didn't seem to want to put in the extra time to learn the system....In reality, most teachers, who were already somewhat overwhelmed with the challenges of the multi-age groupings and trying to work out how they fit into this plan, had little time or energy to learn the IBM system.

Barbara's project led her to examine some far-reaching impediments to implementing change with technology. She explained:

> When I started this project I thought that I could make a difference. I thought that change could happen from the ground up. I thought that because I had excitement I could spark other people. Today I don't think this is true. In order for teachers to be willing to put forth any effort into technology, they must see that there is going to be a payoff.

Barbara showed recognition of this impediment in her discussion of how she planned to work with a resistant teacher who appeared threatened by computers. "I think the only way to work with this teacher," she wrote, "is to work with her kids and let her see the difference in their attitude. Then, maybe she might change her mind."

Enhancing Professional Knowledge

Enhancing professional knowledge occurred for both the teacher leaders in this study as well as the teachers that they worked with. In meeting the needs of teachers in the local context, most information provided by Jan and Barbara was on a technical, "how-to" level. Jan, for example, who helped one of her teacher colleagues learn how to log in and log out of the network, wrote, "I met with Terry before school. Terry practiced how her students would log in and then the steps to quit properly. She [Terry] felt more confident about bringing her class in that morning."

Barbara's action research project, which consisted mostly of teacher interviews and a teacher survey, revealed that she enhanced her professional knowledge of how teachers view technology. From this knowledge Barbara framed additional problem situations in her school and highlighted specific areas for future staff development. At the end of her action research Barbara was able to pinpoint four elements for managing change in her school's computer program:

> I think for any significant change to occur four things must happen. 1) There must be a school-wide vision. 2) There must be a teacher that is able to have release time to prepare and set up inservices, lessons, and equipment to share his/her expertise with the staff. 3) Teachers must be sold on the idea that using technology in the classroom will be worth the effort they are going to put into learning more about it. 4) The administration must back up the efforts put forth by the technology person. Teachers go with the principal's vision, not their peer's vision.

Discussion and Implications

Action research, as a professional development activity holds potential for fostering instructional leadership qualities among classroom teachers. Teachers in this study increased their ability to frame problems relative to computers in education, and they considered site-based activities that encouraged colleagues to use computers in their instruction. As evidenced by Jan and Barbara, teachers also enhanced their professional knowledge of computer education, and used key strategies to foster the growth of knowledge among other teachers. Moreover, by practicing the model of action research given to them, teachers learned research skills, thus supporting Glesne's (1991) claims that learning even a few research skills can help teachers gain insights into their school and classroom contexts.

In addition, action research helps teachers become aware of the change process in schools. While the literature encountered in this course points to the difficulty of implementing educational innovations, the action research led teachers to experience the complexities of the change process first hand and reflect upon it in a very real sense. Despite the clear message that schools are slow to change, Barbara felt that her enthusiasm for the wonders of educational computing would somehow "spark other people". Through extensive interviews and observations, she internalized the depth of the impediments to integrating computers in the curriculum, and she concluded that specified conditions must be present for computers to be effectively implemented at her school site. Through Jan's survey, inservice workshops, and work with individual teachers, her research extended her knowledge of the change process. Furthermore, throughout her journal, Jan included various theoretical memos in which she cited research literature that supported her plans to foster change.

In conclusion, action research holds potential for helping teacher leaders develop a better understanding of the problems of computer implementation and the parameters surrounding educational change. It provides them a real reason to connect theory and practice and a user friendly structure within which to frame problems and explore solutions. Teacher educators should, therefore, consider action research as a viable and promising activity for enhancing leadership skills for teachers who fill the role of technology coordinator.

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The role of the National Science Foundation in supporting innovative technologies in pre-college education

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The National Science Foundation has supported innovative ideas in science and mathematics education for over three decades. Although the focus of that support has evolved over time, the recent changes of the Education and Human Resources Directorate portends major shifts in the educational mission of the Foundation. Historically an independent agency which primarily responds to field initiated proposals, the Human Resources Directorate has been recently reorganized to meet even greater challenges ahead. EHR is now better positioned to be responsive to educational research and support efforts which will produce systemic change. To achieve its mission, it is no longer effective for EHR to foster projects for separate and incremental change. The NSF resources need to be directed towards projects whose combined success will help forge a future where students and teachers within the educational environment interact in ways very different from current classrooms; ways which better reflect the impact of technology on society and on the working environment. As recently as last November, the National Science Board Commission on the Future called for the "integration of science and technology into educational curriculum at all levels and for all students." (Massey)

Technology will certainly be part of our students' future; the way we teach is conditioned by the tools that students have to solve problems. Both imbedded in education and as a topic of study in schools, technology needs to be supported and understood. From networks to multi-media labs, from visualization software to powerful calculating tools, these uses of technology will transform schools, change the roles of teachers and students, and compel institutions to close the gap between how children are educated and how they will work.

A Brief History

In 1984, pre-college education support was resurrected and reformulated based on the National Science Board's *Education for the 21st Century*. In their report, the NSB stated, "The teacher is the key to education...the vital factor in the motivating and maintaining student interest in mathematics, science and technology." It clearly focused on teachers, an emphasis which remains today. Programs built on this foundation with "the formation of partnerships, the emphasis on elementary science and mathematics education, the collaboratives between state governments, industry, scientists, academic institutions and schools, the establishment of proven models for teacher enhancement, the potential of the science museums as sites for teacher programs, and the use of the information technologies in education." (Ethel Schultz, unpublished paper)

The tables at the end of this paper shows the considerable commitment the NSF has made to teacher education programs over the past seven years. The two charts show the growth in the Teacher Enhancement and technology programs as well as the shift in the support to include all levels K-12. Recent reviews by two Committee of Visitors have endorsed the work of the division and added a significant challenge-Teacher Enhancement Program Officers were encouraged to support "high risk" projects which may have less traditional ways of approaching education.

Technology as Catalyst for Change

Technology has changed the society in which we live, and each generation lives incrementally different from the former, so even if current technologies were adequate for today, they would not be for tomorrow. Technology is an empowering force which provides the capability to create an education which is more powerful, appropriate and adaptable than anything previously possible. To the extent that technology forces us to change, it also give us the means to do so.

Technology has made inroads into schools, often without educators giving much thought to the consequences. This has resulted in reform through practice rather than by design. Technology is being used in sophisticated ways in our schools. It is being used to improve the teaching of traditional materials and enhance well-tried methodologies such as we see with CAI, intelligent tutors, and many multi-media applications. These innovations increase our abilities to teach and students' abilities to learn and include some significant improvements in what we teach. These changes have been accepted by the community because they are clearly tied to a traditional view of schools.

Technology, however, raises other and more fundamental questions whose answers are unsettling and challenge us to rethink the roles of the teacher. If technology gives students access to far more information than a teacher could ever know, is the teacher a content or a process expert? Is unguided access to information appropriate or useful for students? Can students discover and formulate important concepts through the use of technology by freely exploring ideas? Does technology redefine the class to be an interest group rather than a room? What are the questions which could be raised and shared with school mates across disciplines and distances?

Computer networks are an excellent example of a technology which gained use first and reflection on its impact came later. Although not yet ubiquitous, the computer connected to local and wide area networks has already changed the concept of the school composed of the teacher-led classrooms and a fixed number of participants. Students nation wide share experiences and data over any of 8000 networks. KidsNetwork is a wonderful example of a network with activities expertly catered to the level and interests of elementary school students. In addition to collecting environmental data, the students share information about themselves and their cultures. Experiences like these have caused many teachers to discover unexpected resources on-line, develop new skills for "mining the network," and consequently, rethink their own roles.

Through networks, students have access to experts on line and to a massive amount of information. For example, logging onto WAIS on the Internet, a student could use *CIA World Factbook 1991* to access a huge amount of data about any country. Searching for Germany shows such facts as Germany has-total area: 356,910 sq km; coastline: 2,389 km; natural resources: iron ore, coal, potash, timber, lignite, uranium, copper, natural gas, salt, nickel; environment: air and water pollution; ground water, lakes, and air quality in eastern Germany are especially bad; significant deforestation in the eastern mountains caused by air pollution and acid rain; life expectancy at birth: 73 years male, 79 years female (1991); total fertility rate: 1.4 children born/woman (1991)...(WAIS).

Computer graphic representations are being used to show students different ways of *seeing* diagrams. Yet students develop intuition by *doing*, not by *seeing*, and this is precisely what the new technologies allow us to consider. The ability to understand how laws and principles (of science) *behave in a new domain*, not only what the laws are (intuition), is an important goal of modern science education. This ability is at the core of the significant changes brought by High Performance Computing and Communications (HPCC) to science, particularly in discipline areas where microscopic phenomena control macroscopic, observable behavior. Exploring "how laws behave" first, and allowing students to manipulate the laws may make teaching more relevant and understandable, and increase the sense of achievement of many students. The question then arises, what should we teach first? Will our strategy work well with students that are currently (or culturally) excluded from personal achievement in science?

Instead of the hit-or-miss use of this new advanced technology, there needs to be a systematic approach to understanding its impact. Modern technologies are so powerful that they change both what education should be and how it should be delivered. They provide the tools with which we can craft a new vision of schools. By providing leadership and the resources to enable the community, the NSF will play a seminal role in helping that vision emerge.

Through closely examining education which uses technology, we can formulate new expectations for children. The NSF views the teachers as the critical element in any change effort. The rhetoric on educational technology needs to converge on the teacher-the most likely change agent for the school. The teacher is the one person who is most able to guide, instruct, support, and assess students in any future school.

Important questions must be answered before schools can determine the amount and appropriate use of various technologies. In light of technology, how will the role of teachers change? How do we best prepare teachers for these changes? How can teachers influence the development of the new technologies whose use they will explore?

Supporting High Risk Ideas for Long Term Gain

With renewed emphasis in the future, the NSF will strive to support projects which use technology in ways which bring about systemic change. These efforts will require real and sustained commitments from the communities with a stake in education, rethinking the roles of teachers and students, and expanding the involvement and resources available for educating children.

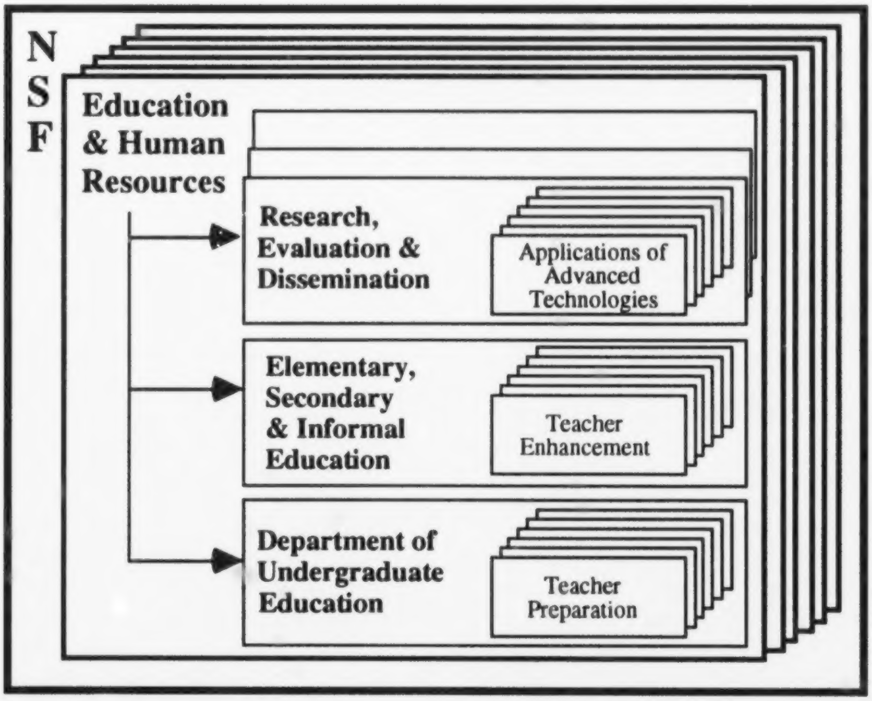
The NSF's Education and Human Resources Directorate is organized into five divisions. Three of these Divisions, with responsibilities which involve K-12 education, are shown below. In each division, various units and sections support projects which involve teachers and technology. These are described in more detail below.

Teacher Enhancement

The largest of the pre-college programs is Teacher Enhancement, one of three programs under the Elementary, Secondary and Informal Education Division (ESIE). Although some TE projects build on the materials developed under Instructional Materials Development (also in ESIE), most still serve the local concerns of the schools. In these, technology has historically assumed whatever importance the local school has been willing to assign to it. With few exceptions, NSF has been willing to wait and see what schools would propose. Moreover, the NSF programs have been organized by discipline as have the panels which review the proposals. However, that now appears to be changing.

Three major thrusts will shape the future support of education-technology, systemic change, and leverage. Traditional workshops will yield to district projects which can better assure institutionalization and systemic change. Collaborations and cooperative arrangements will be the rule rather than the exception. Federal efforts to coordinate funding will probably produce more large projects in which many agencies, including the NSF, have roles. Increasingly, projects will include technologies which do much more than improve the efficiency of schools, they will challenge the paradigms we have used for generations.

Teacher Enhancement needs to help communities


NSF
Education & Human Resources
Research, Evaluation & Dissemination
Applications of Advanced Technologies
Elementary, Secondary & Informal Education
Teacher Enhancement
Department of Undergraduate Education
Teacher Preparation

prepare teachers to assume new roles in a variety of "model" schools. In addition to new curricula in mathematics and science and multidisciplinary approaches, the infusions of educational technologies challenge teachers to expand their repertoires and take on new roles.

Teacher Enhancement wishes to encourage projects which examine and expand the roles of teachers, particularly when the project itself generates understanding of the relationship of the teacher to the students and the educational resources. Teachers have always had roles where they filter, disseminate and assess education. In some schools, they also develop curriculum and manage the classroom. In the new paradigm, teachers must also be facilitators who guide and support students, managers of information and, most importantly, learners themselves.

Today we are beginning to see more classrooms where each student participates and learns in a variety of ways-in cooperative groups, using networks and media, interacting with experts, assimilating new information, etc. The teacher must both manage the classroom and the resources. In doing so, the teacher takes on many roles, often contradictory, and must be able to shift readily. It is the development of these new roles, spurred on by technology, that Teacher Enhancement seeks to include in the types of projects it currently supports.

Teacher Preparation

An essential component of supporting innovative technologies in pre-college education is the development of exemplary teacher preparation programs. Future teachers must be provided with a rich variety of experiences in the use of technology in their own learning at the collegiate level and must also learn how to use technology effectively in teaching.

The NSF's responsibility for teacher preparation was recently assumed by the Division of Undergraduate Education (DUE). The preparation of future K-12 teachers of mathematics and science constitutes the highest priority of the Division. This will require significant efforts to influence the academic culture so that more collegiate faculty members devote their creative effort to instructional scholarship and teaching excellence. It will also require faculty in schools of education and in discipline departments to forge new relationships and partnerships.

Projects supported by DUE fall into two broad funding categories: a few relatively large scale and many relatively small scale projects. The large scale projects provide support for educational institutions and coalitions of institutions to introduce innovative approaches and comprehensive changes in teacher preparation. They are collaborative partnerships of the mathematics, science and professional education communities. The smaller scale projects are of three types. One focuses on the development of courses and curricula, especially at the introductory collegiate level. Another provides professional development for faculty to improve undergraduate teaching. The third supports the development of new or improved laboratory courses or experiments.

The use of technology is a major focus of many projects in each of these programs. Just as technology will be part of our students' future, so must it become part of the lives of teachers and faculty members. Just as technology forces changes and raises questions about teaching and learning in the schools, so must these changes and questions be addressed in the colleges. The new paradigm of teachers as facilitators who guide and support students and as managers of information, resources, and student-active classrooms applies equally to faculty. DUE programs are designed to enable faculty to implement the vision of this new paradigm, thus serving as models for and molders of the next generation of teachers ready to meet the challenge of teaching in a technology-rich world.

Applications of Advanced Technologies

The development of new technologies for education is supported through high risk projects under the "Applications of Advanced Technologies" Program. Research, development and proof-of-concept projects supported by the AAT program address issues at the forefront of technology and its applications to the rethinking of learning and teaching in science and mathematics. The program lays the research and conceptual foundation for:

1. advanced applications of technologies, new science knowledge and methodology, and new national infrastructure for learning
2. accelerating the pace of adoption of new revolutionary computer and communications developments in science and mathematics.

The program supports innovation rather than enhancement. Current non-exclusive priorities for AAT are: distributed systems and communities, collaborative learning, computational science, simulation and visualization, alternative assessment, national strategies for innovation, learning environments and tools, involving teachers in the innovation process

In FY92, AAT awarded 40 grants, many multiple-year, with an average award of $312,000 per year. Funds for FY93 are expected to remain at $12M. AAT funds workshops and conferences designed to set a research agenda in areas of interest to the program.

AAT has funded projects which developed such innovations as Microcomputer-based Laboratories, Logo, KidsNetwork, hypermedia and simulations as well as some projects which flourished in the minds of the proposers then faded. Many of AAT successes have continued funding from the Instructional Materials Development program, which supports curriculum development.

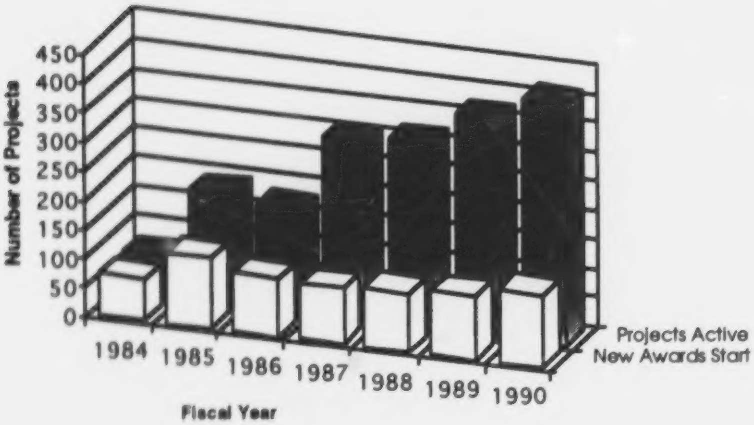
Fiscal Year	Proposals Handled	Awards-New, Continued, Supplement	Awards Amount $Million
1985	524	139	17.5
1986	467	117	19.4
1987	317	117	35.6
1988	287	148	31.9
1989	348	160	44.1
1990	401	189	53.7
1991	655	237	78.5

Teacher Enhancement Programs

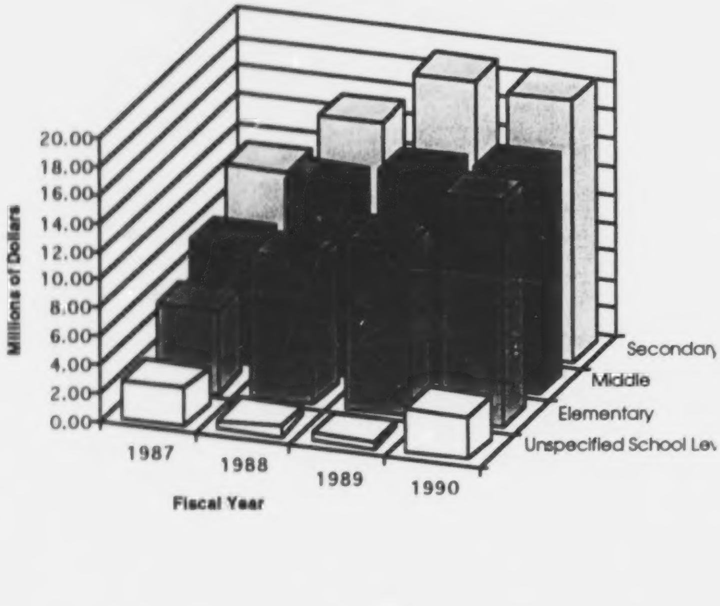
Fiscal Year	Preliminary Proposals	Proposals Handled	Awards-New, and Continuations	Awards Amount $Million
1988		22	10	4.4
1989		24	10	6.0
1990	58	24	6	6.3
1991	162	23	12	12.5
1992	180	65	40	12.5

Applications of Advanced Technologies

Funded Teacher Enhancement Programs



NSF Teacher Enhancement Funding by Level of Education



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PRESERVICE TEACHER EDUCATION

As with previous issues of this yearbook, the papers in this section focus on topics related to the development of teachers who can maximize the uses of technology for teaching and learning. Although the topics span a broad range, from specifying global goals for teacher education to giving precise instructions for delivering a single lesson, the papers, taken as a colloquy: 1) call for the integration of computing into the curriculum regardless of the subject or the age group, 2) emphasize the importance of appropriate modeling behavior in college teaching, and 3) stress the usefulness of building cooperative networks among different levels of educators.

To aid your reading of this section, we have synthesized some recurring themes and have indicated related works whose authors stressed these themes (note that there is some overlap.) It is our hope that this synthesis will allow you more readily to pick, to choose, and to compare at will. These themes are as follows:

- Selecting and using software to match models of instruction; (Byrum)
- Prescribing ways in which technology can be applied to different models for curriculum and instruction; (Copley, Connell, Dubenezic, Meyer & Schney)
- Stressing to teacher educators the importance of modeling appropriate teaching behaviors related to technology; (Hess, Johnson & Marlow, Robinson, Woodrow, Wright)
- Listing steps and techniques for restructuring teacher education in terms of technology; (Dubenezic, Drazdowski, Smith)
- Matching the delivery of technology-centered education to learning styles; (Howard & Howard)
- Delineating curriculum needs of different student populations and different subject areas; (Chisholm, Parsons, Zambo)
- Describing the potential of hypermedia tools for planning and delivering nonlinear instruction; (Connell, Johnson & Marlow)
- Surveying teachers and teacher educators to identify practices related to the incorporation of technology into teaching; (Wetzel, Woodrow),
- Characterizing the establishment of professional

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networks for improving communication, planning, and delivery of instructional technology. (Diem, Meyer & Schney)

- A "humanized" PSI model for teaching the undergraduate educational computing course with hundreds of students and very limited personnel (Fabris)

Another overall unifying theme exists among five of these papers, one that was determined by the authors, themselves. Chisolm, Hess, Meyer & Schney, Wetzel, and Zambo are all members of the Panel Session entitled, "Productivity and Instruction: Molding Technology for the Classroom." Their papers should be interpreted in the context of that general topic.

It is interesting to follow the progression of the educational technology revolution over the past few years and to note the shifting awareness of greater and greater challenges. During the short history of instructional computing we have moved from an infatuation with teaching programming to a concern for producing computer knowledgeable teachers for every classroom and every subject area. This shift is clearly evident in the papers presented here. There is a wealth of provocative material to lead the reader to new questions for research, to new schemes for curriculum development, and most important, to a confidence that he or she is not alone in this adventure.

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Andria P. Troutman, a professor of instructional technology and Director of the Support Team for Academic Computing, also at the same institution, is interested in research and development in the use technology for delivering instruction.

Selecting computer applications: A model for preservice teachers

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Introduction

There are many factors that determine a teachers use of a computer in the classroom. These factors include software preferences, teacher control, familiarity, and instructional approach. Unfortunately, many teachers choose to use computers in limited ways such as drill and practice, tutorials, and keyboarding. Much of this low level use can be attributed to a lack of training, but also to confusion in choosing the best type of computer use for a given situation or objective.

This paper presents a model developed to help preservice teachers select a computer application or use based on the objectives for a lesson. While much of the literature directed toward instructional designers of software advocates the development of applications for specific skills (e.g., drill and practice for discrimination skills), there appears to be little guidance for teachers or preservice teachers in selecting appropriate computer uses (Bell, 1985; Tessmer, Jonassen, & Caverly, 1989).

This model is intended to be only a starting point for a preservice teacher in selecting appropriate software. The model makes no attempt to address the evaluation of software once a type of software is suggested. There are two main purposes for the model: (a) to help preservice teachers analyze their lesson objectives and pick software best suited for the specific learning outcome; and (b) to make preservice teachers aware of the role the computer plays when using various types of software for instruction.

The Model

The model uses two classification systems for selection. First, a classification system based on Type 1 and Type 2 computer uses (Maddux, Johnson, & Willis, 1992) and second, skills based on Gagnés learning outcomes. Shown in the two shaded rings (see figure 1) are the Type 1 and Type 2 computer uses which define low level and high level of computer use based on factors such as program control, user involvement, interaction and responses, creativity versus facts, and program repetition. Gagné (1985) has proposed five major learning outcomes of which three are included in the model. The outcomes divide the circle into three main sections with subdivisions. These are; (a) intellectual skills subdivided into discriminations, concepts, and rules; (b) verbal information; and (c) cognitive strategies (problem solving).

Type 1 and Type 2 Applications

Maddux, Johnson, and Willis (1992) have advocated a classification system for software called Type 1 and Type 2. The classification system attempts to take into account

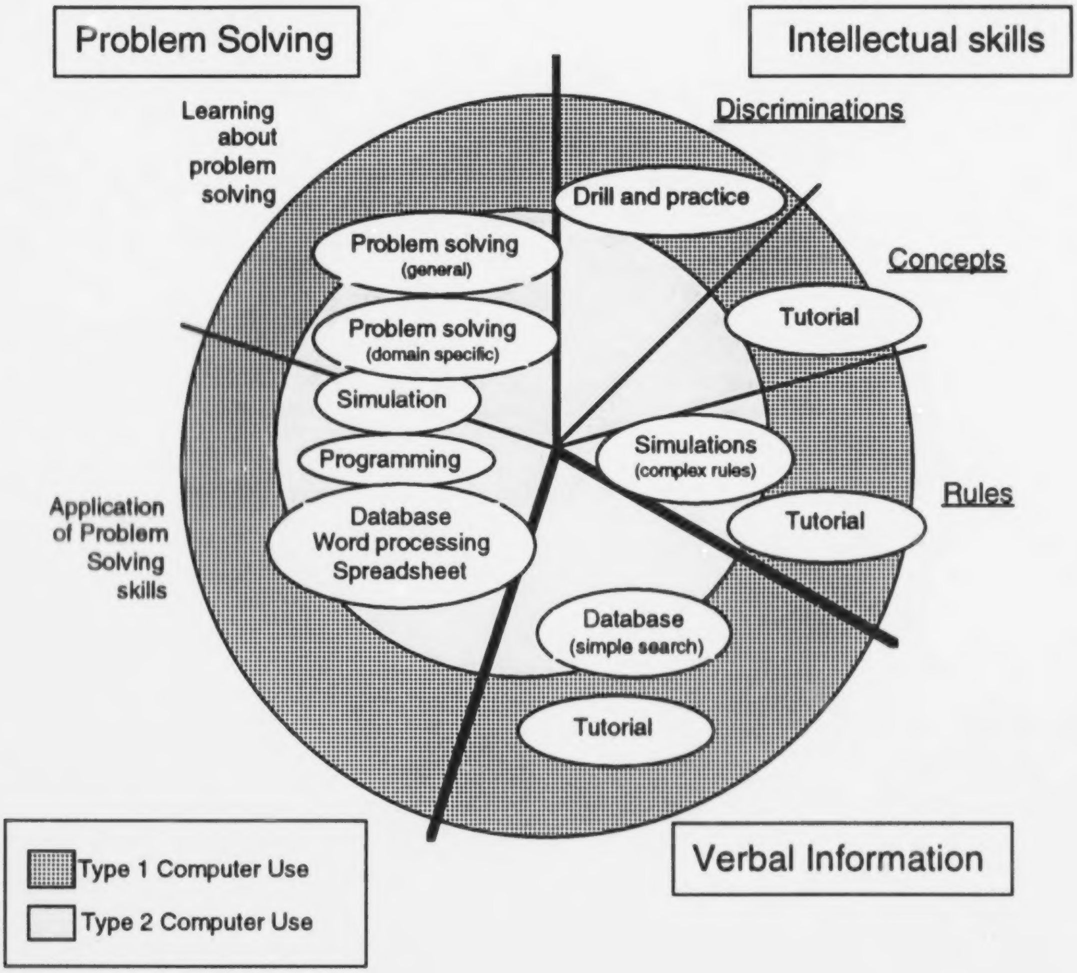
Problem Solving
Intellectual skills
Learning about problem solving
Discriminations
Drill and practice
Problem solving (general)
Concepts
Tutorial
Problem solving (domain specific)
Simulation
Programming
Simulations (complex rules)
Rules
Tutorial
Application of Problem Solving skills
Database Word processing Spreadsheet
Database (simple search)
Tutorial
▨ Type 1 Computer Use
☐ Type 2 Computer Use
Verbal Information

Figure 1

the varying roles and degrees of software and learner interaction, developer design, and level of thinking skill of the user. Common characteristics of Type 1 software are:

1. There is passive involvement on part of the learner. Type 1 does not require the user to apply any high level thinking skills in order to interact with the software. An example is drill and practice software.
2. Software developer decides what the program will do. The developer has predetermined how the computer will respond to student answers and the user has little control over how the program proceeds through the instruction.
3. Interactions are limited by developer. Learner answers must come from a range of responses set by the developer and are usually very limited.
4. Acquisition of facts is main focus. Usually developed to help students with rote memorization skills.
5. Predictability of the program. Everything the program can do is observed in a short period of time and shows little variation.

Type 2 software applications generally contain the following characteristics:

1. Require active intellectual involvement of the user. The learner must engage high order skills to use programs, such as problem solving software, in which decisions and other factors must be considered.
2. User controls screen action rather than programmer. Although every program has certain processes that must be programmed, for the large part the learner

controls what actions the computer takes. For example, when using LOGO the learner controls the actions the computer.

3. User controls interaction with the computer with a wide range of acceptable input. When using word processing the user can edit, search, replace, check spelling and perform numerous functions allowable by the program.
4. Generally involves creative tasks. Utilizing simulation software or designing a spreadsheet requires planning skills and the creative ability of the learner to produce results.
5. Non-repetitive in what the user sees. It usually takes many hours, days, or months before all features or parts of the program have been explored or used. For example, when using a spreadsheet it may take many months before the user discovers and learns all the features and functions available. Also, there is often more than one way for the user to reach the desired result.

Gagné's Learning Outcomes

As stated earlier, Gagné' (1985) proposed five major learning outcomes which are (a) intellectual skills, (b) problem solving (cognitive strategies), (c) verbal information, (d) motor skills, and (e) attitudes. I will not go into a detailed discussion of Gagné's learning outcomes in this paper but if the reader is unfamiliar with these, please consult Gagné's excellent book, *Conditions of Learning* (1985). Two learning outcomes, motor skills and attitudes are not included in the model because most objectives we have encountered use the first three outcomes. While the computer can do a good job of teaching these two learning outcomes, the computer may not be the best or first choice.

Intellectual Skills

Intellectual skills have been further subdivided into the categories of discriminations, concepts, and rules.

Discriminations. Discrimination enables the learner to distinguish one object, event, or symbol from another. Discrimination usually involves naming, labeling, identifying and many paired associate tasks. For example, given a map of the United States, the learner will label the states with their proper name.

Concepts. Concepts allow learners to be able to classify objects, events, or symbols as members of a given class. Once the concept is learned, learners should be able to place objects which have been previously unencountered into the correct class. For example, after learning the concept of adjectives, the students should be able to identify the adjectives in unfamiliar sentences.

Rules. Rules involve a series of steps or procedures which are used to accomplish a task. Many how-to tasks use rules or procedures to reach a desired outcome. For example, to find the perimeter of a rectangle the learner must apply the rule Perimeter = 2 X (length + width) to find the answer.

Verbal Information

Verbal information allows the learner to tell, state, explain or verbalize a fact. Usually verbal information requires rote memorization such as stating the temperature at which water freezes or the date of the attack on Pearl Harbor.

Problem Solving

Problem solving skills enable the student to generate and solve a problem often through the use discovering another higher order rule. The problem solving process is considered a creative skill. Problem solving is further divided in this model into two sections (a) learning about problem solving and, (b) application of problem solving skills. In learning about problem solving there are generally two types of software, general and specific. General problem solving software is designed to teach and reinforce the basics of problem solving and is not tied to any specific curriculum. An example of generic problem solving would be the program called *The Factory* . *The Factory* allows students to develop a base of knowledge, brainstorm, and test the product. Domain specific problem solving software limits the problem solving process to the topic area such as math or science. Domain specific software would be programs such as *Botanical Gardens* in which the students learn problem solving skills in the area of botanical science and genetics.

The application of problem solving skills allows the user to practice those skills in programs such as simulations, programming, languages, and the use of database, spreadsheets, and word processing. Theses applications do not attempt to teach problem solving but reinforce or require the learner to use problem solving skills or steps to successfully complete the task.

Using the Model

The following section of this paper will present several examples of performance objectives illustrating how the model may be used in helping preservice teachers select appropriate educational software.

Sample Objective 1. From memory, the student will list the original thirteen colonies in the order in which they joined the Union.

Clearly, the above objective requires the rote memorization of facts. Objectives which use verbs such as list, state, recite, and define are usually in the verbal information category. Examining the model, the teacher can see that a suggested type of educational software for instruction would be either drill and practice or tutorial software. Both drill and practice and tutorial software are placed in the outer ring and carry the Type 1 software characteristics. If the teacher wanted the student to use a database to acquire verbal information, a simple search in a database would also help in acquiring facts.

Sample Objective 2. When given various plane figure shapes, the student will be able to classify them as square, rectangle, circle, and triangle.

The ability of the student to classify items in a class according to characteristics is an example of concept learning under intellectual skills. The recommended type of software shown by the model for teaching concepts is tutorial in which the concept is defined and given with examples and non-examples. Additionally, explanations of each example and non-example are given for each category along with practice items that require the student to classify examples and non-examples of the concept.

Sample Objective 3. Given ten rectangles with the length and width labeled, the student will apply the formula Perimeter = 2 x (length + width) to calculate perimeter with 90% accuracy.

The above example uses a rule. Rules are procedures, steps, or techniques which are used in sequence and applied to solve a problem correctly. For example, there are many rules for mathematical operations and proper grammar and punctuation. A tutorial program is recommended because it can present rules to students by describing the rule, giving an example of its application and how the rule is applied, and practice items in which the student uses the rule to solve a problem. Rules can also be taught by using a combination tutorial method and simulation software in which the student learns about the rule and then applies it in the simulated setting.

Sample Objective 4. The student will design a spreadsheet which will calculate the square footage of a house given the measurements for three bedrooms, dining room, living room, kitchen, and two baths.

Sample Objective 5. The students will write an original story about a place they would like to visit.

The above objectives both use the process of problem solving. Both require the student to apply and select rules and their combinations to creatively solve the problem. In the first instance, the student may know about spreadsheets and how to enter formulas and the student may know the rule for calculating square feet for an area, but the design of the spreadsheet requires the combination of rules and procedures to create a new process of calculating square footage of a house. Writing a story also calls on problem solving skills. By following rules of grammar and composition, along with original thoughts, the student "creates" a new story.

The application of problem solving skills differs markedly from the other problem solving category on the model; learning about problem solving. Software for problem solving learning attempts to teach the learner steps or methods of problem solving to be used when confronted with a problem. This type of learning is best suited for tutorial software which gives a description of the problem solving process and examples, explanations of how the process was applied, and practice problems which require the process to be used. Simulation software can be used to present problems and students can make decisions and see how their decisions affected the outcome.

Problems and Comments

To date, we have had several problems with using this model. First, is the use of Gagné's learning outcomes. Although widely accepted in the instructional design field, the learning outcomes are rarely taught in undergraduate education courses. Bloom's taxonomy still appears to be the main source for classifying objectives. Most students did not have a hard time converting from Bloom to Gagné' once definitions were given and the outcomes explained. Still, several students remained confused during the whole process.

Second, it had to be stressed repeatedly that the model was only a first step in the process of identifying software for use in the classroom. Several students used the model as an ends unto itself. For example, a student would classify the objectives for a lesson as concept learning, use the model to select the appropriate software type, identify a piece of tutorial software in their subject area and then stop. After further explanation, the student was able to identify several pieces in the subject area and then perform a traditional software evaluation using forms provided to pick the best available.

Another curious observation resulted from the instances in which students after identifying the types of software appropriate for the objective would often rewrite their objective if it fell in verbal information or Type 1 software uses. Perhaps negative connotations were unintentionally passed to students on using drill and practice and other Type 1 uses. Students were reminded in many cases that, though widely overused ill in many cases, drill and practice if often necessary and valid.

Using the model took a large amount of time due to the problems mentioned above. Unfortunately, our program has very tight time lines in which instructional media and computers in education are taught in a two-hour lab for sixteen weeks, so I am unsure of its continued use. I have had much better success using the model in a graduate computers in education class in which a more in depth look at software and objectives is allowed.

Conclusion

The model designed for the undergraduate technology course worked well in spite of several problems. However, for the model to work effectively I believe several conditions need to be met:

1. Students should have a working knowledge of characteristics of the various types of software (e.g., drill and practice, tutorial).
2. Students should be taught both Gagné's Learning Outcomes and the Type 1 and Type 2 Classification System.
3. It should be stressed that the model is only the first step in selecting appropriate instructional software.
4. Once the type of software is identified, students should follow traditional methods of examining both the software and documentation using a software evaluation form to identify the best program from ones available.
5. Ample time must be allotted to teach all of the above.

For the majority of teachers, the most important aspect of instructional computing is their decision on how and when to use computers in teaching. Therefore, it is imperative that teacher training include guidelines on the selection of computer uses based on both instructional design theories and the characteristics of various types of software.

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The use of technology in early childhood classrooms: A constructivist approach to teacher education

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The preservice and inservice teacher education curriculum for early childhood is primarily focused on developmentally-appropriate materials and activities for the young child along with the appropriate instructional methods that will help the young child construct knowledge (Bredekamp, 1987). Traditionally, technology has not been an important component of that curriculum. In fact, there exists a continuing debate concerning the appropriateness of computer technology in the early childhood arena.

To understand the full potential of technology and its effectiveness for teacher education, teachers must have easy accessibility and full usage of technology (Sheingold, 1991). To any teacher educator, the use or integration of technology involves more than just a physical change of additional hardware and software. It is a blend of thinking, learning, and instruction using the tools of technology to form an entire system of learning and teaching (Copley, 1992; Dwyer, 1991). To an early childhood educator, however, additional concerns about the developmental characteristics of the young child, the suitability of technology to the motor skills of the young child, and the use of developmentally-appropriate software to enhance the psychosocial and cognitive development of the young child must be considered (Bredekamp, 1987).

The purpose of this paper is to present an approach to the education of early childhood preservice and inservice teachers in which the integration of technology is one of the desired goals. A modified constructivist model for the integration previously used to integrate mathematics education with technology (Copley, 1992) will be used. From the context of this constructivist model, the sequence of activities include: (1) a review of software using the developmentally-appropriate criteria for early childhood education, (2) the presentation of a debate discussing the issue of the appropriateness of technology use, (3) classroom sessions in which technology use is modeled as it would occur in an early childhood classroom, and (4) reflective interactions between young children, early childhood teachers, and class members.

The Constructivist Model

The constructivist model views teachers as facilitators whose main function is to help students become active participants in their learning and make meaningful connections between prior knowledge, new knowledge and the processes involved in learning. The role of the teacher educator is to design experiences that require teachers to construct their knowledge of the subject content and technology by playing the role of students constructing their own understandings (Brown, Collins, & Duguid, 1989). Constructivists emphasize the importance of appropriate forms of experience. Group forums where conflicting issues can be debated, illustrations of the reality of the classroom by practicing early childhood teachers, and lessons that model the appropriate use of technology could all be viewed as appropriate experiences in the constructivist classroom for teacher education. Both inservice and preservice early childhood teachers need to be involved in situations based in reality to facilitate the construction of knowledge and effectively assimilate new information into existing cognitive structures (Davis, Maher, and Noddings, 1990).

Figure I illustrates a modified view of the constructivist model in the integration of technology and teacher education (Copley, 1992). The interactions between the components of the model indicate that the processes are not sequential but highly dependent on one another. Initially, some relationships between early childhood teacher education and technology are identified. Then, the remaining three components (a) creation of a supportive and inquiring classroom environment, (b) the review, elaboration, and refinement of ideas, and (c) the modeling of dispositions are considered and reconsidered as the model is implemented.

This model of implementation was used with two undergraduate classes primarily for preservice teachers, *The Prekindergarten Child: Development and Developmentally-Appropriate Practices* and *Kindergarten Programs* (n=68) and one graduate class primarily for inservice teachers, *Current Issues and Trends in Early Childhood Education* (n=28).

Relationships between Early Childhood Teacher Education and Technology

One of the most obvious relationships between technology and early childhood education involves the evaluation of curricular materials. The National Association for the Education of Young Children (NAYEC) recently issued a landmark publication, *Developmentally appropriate practice in early childhood programs serving children from birth through age 8* (Bredekamp, 1987). The publication lists, in detail, practices for the enhancement of the physical, psychosocial, and cognitive development of the young child. Both inservice and preservice early childhood teachers must not only have knowledge of the developmentally appropriate practices; they also must be able to apply the DAP criteria to specific materials and instructional methods designed for the young child. For this purpose, a review of hardware and software using the developmentally-appropriate criteria for early childhood education was a necessary experience for the early childhood educator. Preservice and inservice teachers were given a list of ten DAP criteria specifically related to technology use (Haugland & Shade, 1990) and asked to score the use of specific hardware and software according to their perceptions and understanding of developmentally-appropriate practices for students in PreK-2nd grade. *Developmental Evaluations of Software for Young Children* (Haugland & Shade, 1990) listed ten criteria: (1) age appropriate, (2) child control, (3) clear instructions, (4) expanding complexity, (5) independence, (6) process

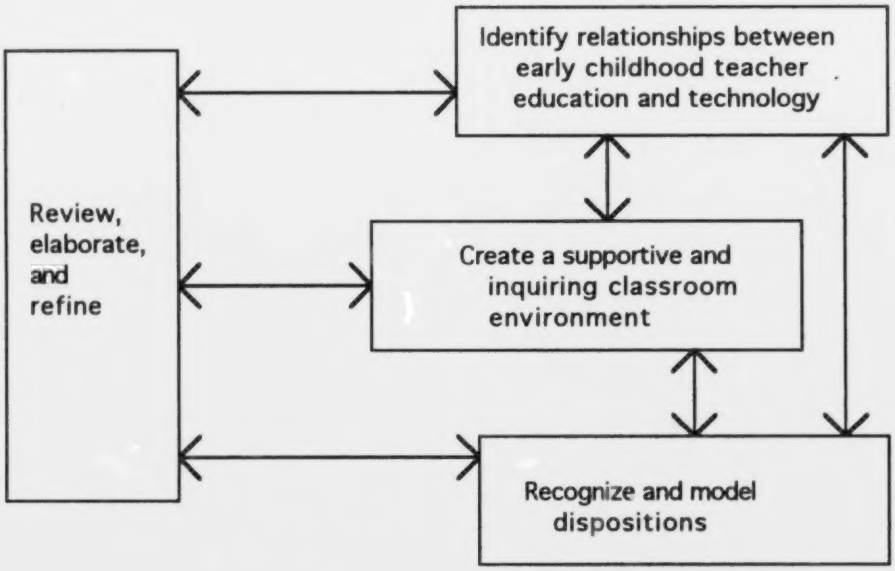
Identify relationships between early childhood teacher education and technology
Review, elaborate, and refine
Create a supportive and inquiring classroom environment
Recognize and model dispositions

Figure 1: Model for the Integration of Technology and Early Childhood Education

orientation, (7) real-world model, (8) technical features, (9) trial and error, and (10) transformations. After a discussion of the ten criteria, partners previewed twenty software packages recommended for young children using both Macintosh and MS-DOS platforms and evaluated their effectiveness. The list (Table 1) included relatively new selections as well as more traditional selections.

After the initial evaluations, preservice and inservice teachers evaluated the software packages several additional times, once after watching young children use the software and another time after discussion with an inservice teacher who had used the software with young children.

Another relationship between early childhood education and technology use involved mostly instructional methods. An inductive, discovery approach to learning is often one experienced by the young child. In fact, it is one of the most common and delightful characteristics of young children and one that needs to be encouraged (Black, J.K., Puckett, M.B., & Bell, M.J., 1992). Preservice and inservice teachers were asked to observe and note the young child's reactions to the use of hardware and software and to formulate plans to encourage their discovery approach. Questioning strategies and reflective listening techniques were discussed and practiced with young children interacting with technology.

Creation of a Supportive and Inquiring Classroom Environment

The discussion, exchange, support, and evaluation of ideas is an important aspect of any teacher education program. To create an inquiring classroom environment, the graduate class, *Current Trends and Issues in Early Childhood Education*, prepared a formal debate of the resolution, "Resolved: The use of computer technology is developmentally-appropriate for early childhood programs." Before affirmative and negative positions were stated and rebutted (Clements, 1991; Davidson, 1989), class members were asked to write their initial opinion of the resolution. The debate was presented in both the graduate and undergraduate classes with time allowed for questions from class members. Opinions were written after the debate was formally completed and informal debates on the merits or concerns of technology use with young children continued throughout the class sessions. The interactions between preservice and inservice teachers regarding technology use helped facilitate the

Table 1
Listing of Suggested Software for the Young Child Used to Implement the Constructivist Model of Teacher Education

Name of Software	Publisher	Recommended Level
Grandma and Me	Borderland	PK - 3rd Grade
Memory: Simon Says....	Sunburst	PK - 2nd Grade
Sidewalk Sneakers	Wings	1st - 3rd Grade
Winker's World of Patterns	Wings	K-3rd Grade
The Pond	Sunburst	1st - 3rd Grade
Cinderella	Discus Books	PK - 4th Grade
Long Hard Day at the Ranch	Discus Books	Ages 3 - 9
EZ Logo	MECC	K-2nd Grade
Measurement, Time and Money: Vol 1	IBM	1st -3rd Grade
Juggles' Rainbow	The Learning Co.	Early Childhood
Magic Crayon	C & C Software	K- 2nd Grade
Paint with Words	MECC	K-2nd Grade
Reader Rabbit	The Learning Co.	Early Childhood
Stickybear ABC's	Weekly Reader	PK - K
Stickybear Opposites	Weekly Reader	PK-1st Grade
Bouncing Ball	Wings	K-3rd Grade
Balancing Bears	Wings	1st - 3rd Grad
Create with Garfield	DLM Teaching	1st-4th Grade
Facemaker	Spinnaker	K-4th Grade
Gertrude's Secrets	The Learning Co.	1st-3rd Grade

construction of knowledge of both groups of early childhood teachers.

Interactions between young children and technology were other aspects of the early childhood classes. Seven young children (4-7 years old) attended the undergraduate classes and rotated through a variety of centers during a 90 minute class period. Preservice teachers observed, recorded, and reacted to the behaviors and verbalizations of these children as they related to technology. Because of their access to young children, inservice teachers were required to try specific software with children in their classes. Reports of their behaviors were presented and discussed with other graduate class members.

Modeling of Learner and Teaching Dispositions

The modeling of software and hardware use was an essential component in both the undergraduate and graduate classes. Using the suggested instructional methods in the software documentation, class members were instructed with a variety of software packages. After a discussion of developmentally-appropriate methods, alternative practices were discussed and implemented with another undergraduate class or with young children. Class members were asked to reflect on their feelings about technology use and the quality of early childhood education from both the learner and the teacher perspectives. In addition, class members were introduced to hardware that was unfamiliar to them. (In most cases, class members were familiar with one platform; another platform was chosen for their initial introduction to technology.) Students' reactions to the difficulties experienced in manipulating a mouse, a joystick, or commands were acknowledged and discussed specifically in relation to the young child's beginning experiences with technology.

Preliminary Results

Obviously, the intended results of the implementation of this integration model in early childhood teacher education classes would be the effective, appropriate use of technology in the classrooms of the preservice and inservice teachers. Because this model has just recently been implemented, the long-term results have not been investigated. However, based on the informal oral and written reflections of the teachers, some preliminary results can be reported. (a) Teachers frequently changed their opinion of developmentally-appropriate software. In most cases, preservice teachers reported that they thought a particular piece of software was too difficult for the young child to manipulate or not understandable. Often, after they observed a young child's use of the software, they reacted to the child's ability to manipulate and understand the software and hardware with surprise. (b) In all cases, teachers reported that they learned more about the possibilities and flexibility of technology use in early childhood classrooms. (c) Preservice teachers and some inservice teachers stated that they felt more capable of changing the instruction suggested within the software documentation to better fit their understanding of the development of the young child. (d) Finally, in almost all cases, teachers reported that they felt more positive about technology use and enjoyed the opportunity to learn more about its use in the early childhood classroom.

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Technology enhanced cases

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Cases consist of vivid, moving accounts of real-life classroom dilemmas which can be powerful tools for improving teaching. Whether written by teachers, administrators, or university faculty, cases offer a problem based snapshot of an on-the-job dilemma and are consciously designed to provoke discussion. During the discussion of a case, participants are prompted to reflect upon their own practice—not in generalities, but by analyzing specific, concrete problems. By situating discussion of teaching and learning to specific contexts and settings, cases keep principles connected to particulars. Since the case is about 'someone else' it is possible for discussants to talk about teaching without ego getting in the way of reflection (Shulman, J. H., 1991).

Because of these, and various other factors, many education methods instructors are using case based discussion as an important part of their courses. The methods used by the majority are based upon traditional use of cases in the legal and medical community, and technology has typically not been considered as a part of this approach.

This paper is based upon the author's work with the case group from Far West Labs and the recent "Using cases in teacher education" conference co-sponsored by Far West and the University of Utah. It provides general background on case methods and their use in education, an example of a case in which technology is used to expand the potentialities of the case metaphor, and discussion of design issues critical in designing a technology enabled case. The presentation for which this paper has been prepared is in 2 parts: 1) the actual case text—constructed in line with traditional case design - which develops a problem with multiple implications for mathematical assessment, content, student construction, and teacher burnout; and 2) a hypertext supplement employing cognitive flexibility theory (Spiro, Vispoel, Schmitz, Samarapungavan, and Boerger; 1987) to highlight these major themes and allow the students multiple passes through this intellectual landscape. This use of technology allows for an expansion of the case metaphor to include: investigations of common themes across families of cases, each constructed according to similar design constraints; archiving of cases so that related cases pertaining to a given thematic strand may be readily identified; video and audio sources to 'flesh out' the case; and extensive participant interaction via student creation of new links in existing information and addition of new perspectives and strands as they become apparent.

Case Methods

The default model for most educators when asked about case discussion is that of an extended Socratic dialogue surrounding a hypothetical situation as used in business or law schools. Although teaching is an equally complex act, the training of teachers has not typically been done using case based discussion. In describing this situation Lee Shulman has said that:

> The case method of teaching does not exist. The character of cases and case methods varies widely from field to field, and even at times within a single field... in teacher education, we are far from any received doctrine or orthodoxy regarding case methods. (Shulman, L. S., 1992, p. 2)

The lack of a well established tradition in use of case methods in methods instruction allows a window of opportunity for the introduction of technology to enhance the case method itself. When technology is used, a crucial issue is the extent to which one relies on the technology, and the extent to which the case is allowed to stand on its own merit as a text. In the work reported here, a Technology Enhanced Case (TEC) begins with a core text comprising the case itself. This text serves both as the students' first exposure to the case and as the basis of all enhancements - whether done by the teacher candidate or by the methods instructor. In this author's cases there are not a lot of context or happy endings. The focus has been to write something specific enough to engender conversation while remaining general enough that it can be widely used. As might be gathered from Shulman's comments quoted above, this is not the only style of case writing. A flavor for the richness and variety possible in the writing of cases may be found in: *The intern teacher casebook*, 1988; *The mentor teacher casebook*, 1987; or *Case studies for teacher problem solving* (1991) which are cited in the reference section of this paper.

The particular case that will be described in this paper is that of "Dear Miss Sally Brown". With this as both caveat and introduction, let us turn to the core version of the case. Since this forms the basis for the discussion, it is very helpful to actually take the time to read through it. The foils to consider as you read the case are: 1) What types of things happened? and 2) How do you feel about it?

The Case

To think that this was the year that math was going to be different! No more of the boring book and the old impersonal lecture first—assign a page second go round. Yeah, sure... To think that I almost believed it might work...

My class had been working for a little over two weeks on division, "sharing," as we had called it. I had been using Base10 blocks to demonstrate and I had just finished grading a quiz where they drew sketches showing how they would "share out" some problems. Although most of the kids did well, there were enough who did not that I decided I should talk to a few students to see how they were doing. Sheesh, was that a mistake.

I had been using a set of Flash cards to pick out exercises and then giving the student the related problem orally in a "share with" format. So, a problem might be to "share" 72 counters with 9 people. Without exception, each of the five students I talked with was able to select the correct number and type of Base10 blocks.

I was pleased to note that four of the five students were able to successfully complete the exchanges necessary to get the correct answer. Although they often used different procedures than what I had shown them in class, they were at least able end up in the right place. For the most part, the kids were able to describe numerous situations in which such "sharing out" would be desirable.

I suppose I must have been a little tired on the sixth kid, because instead of posing the problem orally, I just showed Lenny the problem on the Flash Card and asked him to do the problem. Instead of having a "share with" situation, he was faced with just the cold math exercise—so the example above of sharing 72 counters with 9 people looked like 72/9.

The response was both immediate and discouraging. Lenny: This is a *Dear Miss Sally Brown* problem! We learned how to do these *ages* ago... see, you just *divide, multiply, subtract, bring down...Dear Miss Sally Brown.*

Not only had he forgotten everything he had learned about "sharing" and using the Base10 blocks, but in applying the steps of *Divide, Multiply, Subtract*, and *Bring Down* Lenny failed to perform a single step correctly—with the result that the answer was 720! To make matters worse, the attention to sense-making and reality checks shown by the other students were no where to be found. The strength of *Dear Miss Sally Brown* and its associated "right procedure" proved too much for the him to overcome. Flustered, I asked him to do the same problem using the "share with" format, and he was able to perform as well as the previous five students—without even realizing that anything had gone wrong.

I went back to the students I had talked with earlier and, although they were at least able to get the right answer, *Dear Miss Sally Brown* won out for three of them. As long as the problems were given as "share with" these students were able to think about their work, select the right blocks, and give examples. Whenever an exercise was presented in standard form, however, Dear Miss Sally rose its ugly head and the blocks were forgotten with no attempt at sense making, estimation, or checking on the part of the students.

I wish I had just recorded the scores and let it ride. At least I would have had the illusion of success. Now I am stuck with the knowledge that Dear Miss Sally has beaten out my hard work of the last two weeks. I should have just left well enough alone and stuck with the book.

The Discussion

This discussion is organized around two themes. The first theme concerns design issues to consider in constructing a TEC. The second theme is how one might conduct a case discussion using a TEC. Since it is not possible to illustrate the interactive nature of the presentation, efforts will be made to describe the links to the extent possible.

Design considerations for constructing a TEC

In actual design, it is critical to start with a well established case with which you are familiar. The cognitive thinking demands of constructing a case *alone* is tremendous. To try to write a case while at the same time considering the technological enhancements that could be added might be overwhelming. This was the reason for selecting the case of *Dear Miss Sally Brown*. This case, as presented here, was collaboratively written by the author and a local teacher and has undergone extensive revision, testing, and feedback.

Once the case has been selected the enhancements may begin. When using technology to enhance a case it is important to not inadvertently replicate any of the features of the old "drill and kill machines" which present text and then require an exact response. Although certainly feasible, such an approach offers little value added to entice the use of a TEC. In a TEC we don't want students responding to the machine. We want students who are using the machine as a tool to develop their own understandings. Clearly this perspective has embedded within it some specific beliefs about what knowledge is all about, what evaluation of that knowledge might look like, and about how we can facilitate the construction, evaluation and sharing of information.

A primary belief that was used to guide all of the author's TEC construction is that humans are innately problem solvers. We learn best when our automatic assumptions are violated—that is, when we have a problem. It is when we come across something that is unique to our experience, that we have not seen before, that there are not standard forms of solution that are widely recognized, that we have to think (Connell, 1992). Random experience, however, is not necessarily the best teacher. A TEC should possess an internal framework for the discussants to use to enable specific ways of looking at the performance as a teacher of the case's protagonists. It is helpful to have common themes that cut across cases. In constructing a TEC, explicitly identify your basic themes and how and where they occur within each TEC. In the design process, take your internal mental representations and put them in an external form so that they are available for discussion and reflection. In laying out this framework, remember that people have very different mental representations for the same type of experience. Every effort should be made to bring the reader into the world of the case with all of its complexities and relationships.

To maximize the utility of the developed TEC the author suggests that you strive for across platform ability. The TEC for *Dear Miss Sally Brown*, although developed using ToolBook on an IBM compatible computer, would work equally well under HyperCard on the Macintosh system. To enable ease of portability, nothing in the developed case took advantage of unique features of either authoring system. Four basic programming elements common to both HyperCard and ToolBook are used by the author when designing a TEC: 1) Fields; 2) Buttons; 3) Pictures; and 4) Hotwords.

At the simplest level, you push a button, write information in a field, and illustrate using pictures. You can script a button to perform an action, switch to the next page, call up another piece of information, show all of the cases with a similar theme, and so on. Depending upon your skill in the authoring system and access to external resources, the sophistication of these basic objects can be increased significantly. For example, consider a button which brings up an enactment of the case on videodisc that links to a panel of experts which may be clicked on to get opinions. The enhancements possible are tremendous, but each should be considered in light of the underlying framework which was earlier defined. It is important not to try to create a TEC by merely throwing technology at the case. Each enhancement should be carefully considered in light of the themes that the case is designed to engender.

The author makes extensive use of hot words throughout each TEC. Hotwords serve as the primary navigation tool within the case. Since a TEC begins with a case which serves as the center of the instruction, the use of hotwords as a navigation tool reinforces the centrality of the case text while providing an easily used interface for the students. The students learn quickly that anytime in the case text they come across an underlined word and click on it something will happen. Hotwords are selected and created to enhance one or more of the major themes identified within the case. The actions these hotwords perform are designed to extend and challenge our understanding of the ideas presented in the case. Themes recur throughout the case from a wide variety of perspectives.

In thinking of the enhancements possible, it is helpful to broaden your definition of what is possible with pictures. Depending on how you set it up and how much risk you are willing to take as you take equipment into the field, it is possible to include interactive videodiscs, stills from CD-Roms, live video shots, and so on. This phase of the design of a TEC is a tough job. An unenhanced paper case brings students closer to the real world situation it came from. Depending upon the effort and video interaction you put in on the technology enabled case, you are bringing students even closer. It is important to present a balance between the ill structuredness of the classroom environment that you are representing, and the well structuredness that needs identification so that logical argument or discussion can develop. One of the goals of a well designed case is to bring the reader into the virtual world constructed by the case - be sure that this world is accurate.

The author is committed to having multiple paths through any case defined ahead of time as there is no way of telling which path a given group will be interested in. To see how this might work, let us refer back to the case itself. By traversing the intellectual terrain from a variety of perspectives, the students have the opportunity to see the complex nature of the teaching situation and to practice possible solutions and investigate their implications. Technology helps to make this complex environment manageable and enables us to explore cases in a truly unique way. You may decide for example to include a link between this case and another case showing a similar theme. Suppose the students had never seen a base ten block before. The scanned image showing the children's work is only a mouse click away.

Conducting a case discussion using a TEC

Remember learning to ride a bicycle? Remember how it felt when you first started? Terrifying wasn't it? If your experience was anything like the author's you probably felt like there were forces seeking to throw you to the ground and succeeding quite often. In the face of these conflicting problems, though, most people do succeed in learning to ride. Initial experiences with teaching with cases is often a lot like that. Consider this as an attempt to capture a "talk-aloud" in print on how the author would go through a case discussion using technology as an enhancement to the original case. Although this case has been extensively used by the author as a part of graduate and undergraduate methods courses, the STATE presentation marks the second time it has been discussed in its technologically enhanced form in front of an audience as opposed to a classroom.

In using a TEC to present a case it is important to allow time for a joint construction of meaning. In this process, it is important to think carefully ahead of time through the representations that are used. Special attention should be given to any features unique to the case or those features used in a different fashion than currently accepted. It is important to go through the ways those representations are mapped out, and plan time to reflect on the structure of the case itself. Some of this can be done in passing, such as: "This is what we mean by a hot word. Here is what a hot word looks like in this case text. Here is what happens when we click on the hot word..." and the like.

In leading the discussion it is important to remember that the case isn't based on technology, it is based on a problem in teaching—in this case elementary mathematics. As you gain experience with TEC's you must be willing to weed out features that detract from the flow of discussion regardless of the time investment in their creation. Don't expect to cover every nuance of the case in a single setting; there are themes within the case which take quite awhile to thoroughly explore. In looping back through the terrain, it is common to find that on the second and third passes you encounter a different set of questions than those asked the first pass through.

Let's take a sample pass through the TEC. We read up to the point "this was the year that math was going to be different! " After clicking on the hotwords *math was going to be different*, we are presented with a series of classroom layouts and provided with a scrolling field within which to describe which type of teaching each of these classrooms would facilitate or hinder. Questions are posed which force us back to reflect upon predefined themes. What kind of class do you think that might be? How about this one? How about this one? After responding to these open ended questions, we are returned to the case at the point where it was left for further exploration and reflection.

A guided walk through of the type described above, however, is a poor imitation of the dynamics of working through a TEC. When students go through this type of landscape on their own, they take many different paths through it. They hit different themes at different times, based on their exposure to the cases. Themes and strands become manifest through exposure and experience and students begin using them as guiding filters in a very complex area. What does it look like from this perspective? How are these two elements linked? This guided reflection is valued and to be promoted.

It is expected that the students have read the case before they come to the class, along with any supplementary readings. For this TEC, I expect that the students have also read the first chapter of the NCTM standards (NCTM, 1989), gone through a classroom experience aimed at developing their own understanding of the content reflected in the case, and read the piece by Stan Erlwanger on his conversation with Benny (Erlwanger, 1973). From these perspectives the students start cycling around the issues of the case.

Summary

Technology enhanced cases offer the possibility of bringing the student more thoroughly into the world of the case. As with any use of cases, however, extreme care must be taken in their creation. The developer must be familiar with the nuances of the case and how the main themes in this case relates to other themes in other cases. If the developer remembers to look carefully at how technology can be used to enhance the key themes of the case and articulate them thoroughly - not just throw in features for their "whiz-bang" effect - technology has much to offer both the case designer and the user of case methods.

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Visions of the 21st century school: Implications for restructuring the preservice instructional media/technology course

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The current reform movement in education, which has been accelerating over the past decade, is attempting to redefine the goals and structures of our educational systems in order to meet the needs of the post-industrial/information-oriented world of today and tomorrow. Much has been written on what our restructured schools should be like and how technology can help educators create teaching and learning environments that are appropriate for learners who will spend most of their lives living in the 21st century (David, 1991; Frick, 1991; Hefzallah, 1990; Pearlman, 1989; Sheingold, 1991; Thornburg, 1992; U.S. Department of Labor, 1992). A review of this research reflects an increasing view that schools will need to change from a didactic teaching approach (which focuses on information transmission through lectures, student memorization of facts and test taking) to a constructivist model (in which teachers, in their roles as managers and facilitators, promote active learning). This kind of learning becomes much more individualized and meaningful, with students often working collaboratively with each other.

Those of us in teacher education cannot prepare teachers to function in this type of environment by talking about it. We must model the kinds of thinking, communication, and management skills that we want them to use in their own teaching. This paper will first identify some of the essential elements of a student-centered, technology-rich, active learning environment that many of today's reformers are insisting is necessary to prepare students for a successful life in the 21st century. Then a series of questions will be raised concerning the goals and structure of the introductory preservice educational media and instructional technology course taught at many colleges and universities.

Essential Elements of a Student-Centered, Technology-Rich, Active Learning Environment

Allan Collins (1991, pp. 29-31) identifies eight major trends affecting learning in schools that may result from the increasing use of computer technology in an active learning environment as opposed to a more traditional, didactic one. These are:

1. More use of small-group instruction
2. A shift in the teacher's role from that of a lecturer to a coach or facilitator of learning
3. Increased interaction with weaker students
4. Students being more engaged in learning
5. Student assessment based less on test performance and more on products, progress and effort
6. A shift from a competitive to a cooperative social structure
7. A shift from all students learning the same things to different students learning different things
8. More emphasis on visual thinking

David Thornburg (1992) envisions schools that allow students to use technology in creative, thoughtful ways. Textbooks are replaced by information-rich electronic resources that contain still and motion pictures, graphics and sounds. They allow the learner to explore information and ideas in many different and flexible ways. With the use of newer digital technologies and hypermedia programs, traditional written and oral reports become interactive, multimedia presentations. Additionally, with extensive use of telecommunications, students are no longer bound to learn within the confines of their school. In Thornburg's vision, accessing and sharing information on a global basis is an on-going process in schools of the 21st century (Kurshan, 1991).

In *Learning a Living: A SCANS Report for America 2000* (1992), the U.S. Department of Labor examines the skills that young people need to succeed in the world of work, both today and in the early 21st century. The kinds of learning environments that will be necessary for students to learn these skills are very different from the conventional classroom in many ways (p.42):

1. Teachers don't know all the answers and there may be multiple solutions to problems that are presented.
2. Students routinely work with teachers, peers, and community members.
3. Students and teachers plan and negotiate activities.
4. Students routinely assess themselves and communicate information to a variety of audiences, not just the teacher.
5. Organizing systems are complex rather than having one teacher with 30 students.
6. Various subjects are integrated into a problem solving approach and listening and speaking are fundamental aspects of learning.
7. Thinking involves problem solving, reasoning and decision making.
8. Students are expected to be responsible, sociable, self-managing and resourceful.

To prepare a person for an effective life in the 21st century, Ibrahim Hefzallah (1990, Ch.2) would create a learning environment that is flexible, interactive and rich in learning resources. It would be staffed by persons (teachers) who:

1. Can answer questions and question answers.
2. Rejoice in discovering facts and learning new things.
3. Consider learning as a life-long process.
4. Are not afraid of change and are willing to examine change carefully and objectively.
5. Have articulated their values and have compassion toward other people.
6. Respect all individuals and find delight in communicating with other people.

If those of us in teacher education programs in general, and media and technology courses in particular, are going to have an impact on and play an important role in the school reform and restructuring efforts now happening, we will need to incorporate the kinds of learning environments that these writers are suggesting into our own teaching. We will also need to be the kind of person Hefzallah has so eloquently described.

Creating Effective Learning Environments for Pre-Service Technology Courses

There is evidence that teacher educators involved with instructional technology are implementing some aspects of the activist, constructivist learning perspective that was discussed in the preceding part of this paper. At the Third Technology and Teacher Education Conference held in Houston, Texas March 12-15, 1992, several papers were presented that focused on current educational reform and school restructuring efforts and their implications for teacher education. Among these papers, those by Biglan (1992), Copley (1992), Downs (1992), Handler (1992), Henderson (1992), Stowe (1992), Strudler (1992) and Whitman (1992) have been especially helpful to this researcher in his continuing efforts to identify and answer questions about the kinds of learning environments that are appropriate to prepare preservice teachers with the skills and attitudes necessary to be effective teachers in our technology and information-based society.

As teacher educators prepare for and organize the technology-related component of the preservice teaching experience (whether that be part of a methods course or a separate media or technology course), they need to thoughtfully develop and answer a series of questions. These relate to the goals, activities, structure and assessment procedures that will be used and how they might be different when designing a course from a constructivist view of learning. The following questions, reflecting some of the ideas presented earlier in this paper, are suggested as a starting point for this endeavor:

- What content should be included in this component to prepare preservice teachers to teach in schools of the 21st century? (Downs, 1992)
- What "literacy" skills should this experience help preservice teachers to develop? (ALA Presidential Committee on Information Literacy, 1989; Hefzallah, 1990)
- How important are the goals of shaping attitudes and developing understandings of broad concepts about schools, learning and technology relative to "covering" a prescribed body of content and information? (Apple Computing, 1991; Strudler, 1992)
- Is the use of a traditional textbook appropriate for such an experience? (Thornburg, 1991)

- How can this experience help prepare preservice teachers to make decisions about solving real problems? (Copley, 1992; Hefzallah, 1990)
- How can cooperative and collaborative learning environments be effectively established and used? (Adams, Carlson, Hamm, 1990; Nattiv, Winitzky, Drickey, 1991; Johnson, 1991; Totter, 1991)
- What are desirable behaviors for higher education faculty to model for preservice teachers that would prepare them for using technology in active learning environments? (Hunkins, 1987; Handler, 1992; Whitman, 1992)
- How do we help students adjust to and accept the roles of an active, collaborative, problem-solving learner, who has much more responsibility for making decisions than students traditionally have had in the past? (Nattiv, Winitzky, Drickey, 1991)
- What kinds of technology-related experiences can best be done outside the higher education classroom and how could such activities be implemented? (Biglan, 1992)
- What kinds of assessment and evaluation procedures are appropriate for active learning environments? (Thornburg, 1991)

In seeking answers to these questions, we may be able to create a learning environment for our teachers that reflects Albert Shanker's perspective on learning, that "...for most of us, the best way of learning is by doing, by making and unmaking something, solving problems and investigating for ourselves the answers to questions we are made to care about."(Pearlman, 1989, p 14)

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Process-centered applications in field based teacher training

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For the past several years, professors of methods courses at Governors State University south of Chicago have been teaching the courses in area public schools. The theory behind this was that preservice teachers (PST) need not only to have experience with elementary students, but also to allow professors opportunities to present demonstration lessons in real settings with real students at varying grade levels. In this way, preservice teachers can get a sense of what schools and elementary students are really like before student teaching. These experiences may or may not be models of the best professional practices, but even poor examples can contribute to knowledge of what one does not wish to emulate.

Practices in the above-mentioned methods course have been refine over several years based on course evaluations and observations. When the program first began, students spent many hours working with small groups in the back of the classrooms. When classroom teachers had difficulty with the group in the back disturbing the others by "having fun," the groups were asked to move to the school library or the room in which the methods class was held. This solved one problem and created another. While the distraction was gone from the regular classroom, the interaction of the classroom teacher and the PST diminished or disappeared. By the end of the semester, the classroom teachers viewed the small groups as an intrusion to their regular instruction and as another pullout program. The teachers' evaluation of the program at the end of the semester was blistering.

With the help of practicing teachers, the program was refined to the mutual benefit of the teachers, the PSTs, and the university faculty. Instead of pulling small groups out of classes, entire classes were invited into the methods classroom or the PSTs went to visit the regular classroom. The professor presented a 10-15 minute demonstration lesson followed by small group sessions taught by the PSTs. Classroom teachers were encouraged to observe individuals or small groups of students, pick up some new teaching ideas, or to discuss the teaching of particular topics with the professor while the small group instruction progressed.

Computer Infusion

By the time PSTs get to the methods courses, they must have taken a course which combines computer literacy and the use of computers in the classroom. However, they lack experiences in the application of these ideas with real children. In order to provide this practical experience and to demonstrate the infusion of computers into instruction, five computers were loaned to the school by the university. This was done not only to have computers available for PST and professors' use, but to provide additional resources for the classroom teachers due to the lack of school resources. The number of computers in the school of over 800 students was more than doubled. Due to the ratio of students to computers and the low income of the majority, most students have had little computer experience. In addition, few teachers on the staff have had any experience with computers, especially as educational tools. Therefore, the methods professors volunteered to provide computer literacy training for teachers with an emphasis on process and application.

The methods classes meet two days a week in the classroom which houses the computers on loan. Software is also being loaned to the school to supplement their very limited selection. The other three days the computers are available for teachers to use with their students or to experiment and practice on their own. The computers are even used after school for small group enrichment and remediation in a district program entitled Project Extra.

The main reason for taking the computers out to the school was to model the use of computer-based and computer-aided experiences for PSTs (Munday, Windham, & Stamper, 1991). In this way, the PSTs could become directly involved in applying the model to their choice of instructional modalities when faced with the task of designing lessons. Trying these lessons with real children provides an eye-opening experience in planning and adapting to the real-world problems encountered when the hardware , the software, or the students don't behave as expected.

Incorporating Process-Centered Activities

In process-centered learning, the computer is used as a tool, rather than as a tutor or tutee (Taylor, 1980). The students create or manipulate their own materials rather than passively absorb the traditional teacher-disseminated information.

Fillebrown-DiDomenico (1992), in discussing a process-centered computer-integrated science plan stated:

> The nature of many of these technology-based activities encourages students to respond and react to a wide range of traditional non-technology skills. These skills include research skills and cooperative learning, . . . problem solving strategies, creativity, sequencing skills, and data collection and organization . . . to name a few. (p. 21)

Other process skills which ought to be considered are decision making, discovery learning, and critical thinking. These kinds of skills cross over subject matter boundaries, since they can be used in most curriculum areas. The use of activities which foster the above-mentioned skills allows the teacher to use time more efficiently, since language activities such as writing are combined with mathematics, science, or social studies.

Mathematics Activities

LogoWriter is used as a vehicle for discussing ways of teaching elementary geometry concepts. PSTs are encouraged to go beyond creating the simple regular polygons frequently associated with LOGO. By rotating common polygons, many new figures can be created, such as flowers, pinwheels, or stars. Similarly, common polygons can be combined in superprocedures to create scenes from everyday life. Students are then encouraged to write about the scene they have created.

Elementary students often have difficulty identifying plane figures whose bases are not sitting horizontally. PSTs are asked to create screens which show plane figures in different orientations. The shapes are drawn to be the same size as pattern blocks. The screens are then printed out. PSTs work with elementary students and the printed screens to match the block to the outline on the sheet of paper and name the shape.

Patterns can be easily created with the use of the stamping feature of LogoWriter. Children enjoy changing the shape of the turtle and stamping these shapes across the screen. By printing these out using PRINTSCREEN, students can attempt to stump their neighbors by asking them to figure out what the pattern is or what shape would come next. The same kind of activity can be accomplished with the stamps in KidPix without as much programming skill as that required for LogoWriter.

Science Activities

The process-centered activities used in the science methods course focus on the use of the computer as an organizational, planning, data-gathering and manipulating, and communicating tool. The emphasis in the course is on the use of science process skills, higher order thinking skills, and the development of science concepts from actual hands-on experiences. The computer activities are molded around this emphasis.

An example of the activities used is the use of grade-level teams which are established to work with the cooperating teachers at the school. Teams are asked to use a word processing program to create a lesson plan for use in teaching a science lesson to a classroom in their grade. They are to base their lesson on science experiences they have had in the methods course. They have previously used the word processor to record their observations, procedures, data, and reflections on those experiences. When they have finished the basic plan, it is reviewed by the professor who makes comments using the word processor. Before receiving final approval, the PSTs use desktop publishing or other programs to create data collection sheets, worksheets, or other embellishments to their hands-on lessons.

Another activity combines steps in experimental procedures with the cut and paste commands. Procedures, scientific problem solving methods, or sequential science content data are created and then presented as a word processing document with the set of instructions out of order. The PSTs use cut and paste commands to put them in the proper sequence. Then they are to create their own sequences for use by others in the methods class.

Other activities involve use of the computer as a microcomputer-based laboratory to gather real data such as temperature, speed, pulse rate using interfaced equipment. These activities are designed to help increase understanding of basic science concepts which prospective science teachers should know (Vitale & Romance, 1992).

Social Studies Activities

The activities that the PSTs use in Social Studies methods serve several purposes. One is to provide a tool that can reflect the tremendous expansion of content in the curriculum, and the other is to liberate teachers from some of their management duties. Searching and reading information in databases, creating databases from current data, and using the computer to modify outdated material in textbooks are some of those activities. The PSTs are asked to create databases about the local school, the class with which they are working, the neighborhood, community, and other elements of real life that are relevant to the students. Since the PSTs are predominantly caucasian and the students with whom they are working are predominantly African-American, these databases provide means of comparison with their home communities or other school experiences. They are then expected to use the databases as part of lesson plans.

The PSTs and the cooperating teachers are beginning to use computers to create lesson plans, word searches, and bulletin board materials. They are also taking a more critical look at the commercial software to evaluate it for possible use. PSTs have designed posters and signs to enhance the instruction of the small groups of children with whom they are working in Social Studies.

Integrated Activities

Perhaps the greatest benefit of the process-centered approach is ability of students to use the process skills across the curriculum. Thus, integrated units lend themselves especially well to the incorporation of process skills. An example of this type of unit are the M & Ms activities which have become a staple in many subjects (Niess, 1992). These cover such topics as data collection, graphing, classification, probability, and predicting.

PSTs are asked to view the program *Woolly's Garden*. They then create an integrated unit using Hopkins' (1992) "Working with Woolly" as a model. This unit must reflect student involvement in process-oriented activities with connections in mathematics, science, and social studies.

The impact of such process oriented activities on the subsequent use of technology in the classroom by PSTs and the cooperating teachers will not be known for some time. While formal evaluation is underway, it is difficult to quantify the number of "Teach me how to do this" requests that occur each day.

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Managing information: Using the computer to increase productivity—meeting the needs

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Introduction

One of the early expectations for the adoption of the microcomputer in schools was that it would free the teacher to have time to perform more direct instruction with students as well as providing instructional assistance. The microcomputer offered the teacher a tool that would store, retrieve, and print the daily information needed in a typical educational setting. The notion of the microcomputer as a tool, tutor, and tutee reflected this integration of the microcomputer as a device to manage and direct information. Business has long understood this concept of information management. The business worker needs prompt access to data sources, needs to be able to store new information as it becomes available, and needs to be able to integrate these sources to produce reports, summaries, etc. How different is the role of the educator?

The state of California recognized this need when it passed legislation requiring every teacher to be able to employ a microcomputer to: show competency in application packages (including word processing, spreadsheets, data base managers, graphics, and communications) and instructional productivity software (including test construction, record management, instructional material design). The *International Society for Computers in Education* (ISTE, 1991) also recognized this when they identified three of their 12 entry-level competencies directly corresponding to this issue. These three are:

- demonstrate knowledge of uses of computers for problem solving, data collection, information management, and decision making.
- be skilled in using productivity tools for professional and personal use, including word processing, database, spreadsheet, introductory desktop publishing, and print/graphic utilities.
- use computer-based technologies to access information to enhance personal and professional productivity.

Many educators have called for revisions in the technological training of teachers (Hess, 1992; Corey, 1991; Young, 1991; Fulton, 1988). Each of these writers has described the type of training needed by preservice and inservice educators, and each has included a module, similar to ISTE's and the state of California's. According to each of these writers, training must include the use of personal as well as professional productivity software (as well as their application). Typically, these types of software include spreadsheets, databases, communication packages, word processors, and graphic creation programs.

How well have we done? A quick, informal survey of ten teacher education universities in the Southwest, West, and Midwest found that all ten had a course in computer applications for teachers. Each of the universities provided: (1)a general unit in computer applications and instructional software, (2) a personal application unit that included word processing, databases, and spreadsheets and (3) instruction in computer systems and hardware. This is where the similarities ended. Four of the ten taught a unit in programming (three in BASIC, one in Logo), seven of the schools taught the courses on *Apple IIe's* or *Apple IIgs's*, two were exclusively *Macintosh*, one was on either a *Macintosh* or DOS-based system. When asked about the personal and professional productivity units each indicated that they used an integrated package to train their students: seven used *Appleworks* and three used *Microsoft Works*. When asked whether colleagues in other programs, content and methodologies, taught computer applications in professional and personal productivity, nine replied that some did, but only on a limited basis, while one expressed full confidence that students did not receive any additional instruction on the topic.

A recent report by the Department of Education in Arizona (1992) details the type of microcomputer equipment in use in the schools. Nearly 70% of the schools relay heavily upon *Apple II*'s or older machines. Nearly two-thirds of the remaining schools relay upon *Macintosh* systems, the rest employ some type of DOS-based system. While there is no report upon the availability or type of platform used directly by teachers, one must assume that it tends to parallel the percentages reflected in the school report.

Downs (1992) reports that schools of education must be prepared to train teachers to meet the technology needs of the 21st century. This theme is echoed by Hess (1992) and Wetzel (1992) as well. Yet, except for a limited perspective, all three focus upon the application of the microcomputer for instructional assistance, not in the development of personal and professional competencies. It appears that one significant feature of adapting any new innovation, the personalization of it, is lacking in most training programs. Teachers, if they are going to truly reap the benefits from technology, must make that technology theirs. As Young (1991) notes, teachers must learn to employ the technology available to them as readily as they might employ a pencil.

Why are teachers not employing this tool to ease their work loads? Perhaps it is as Handler and Marshall (1992, p. 387) suggest: "The sense of feeling prepared through one's program to use computers in the instructional process appears to also impact on the degree to which new teachers actually use the computers in their classrooms." Perhaps the same may also be said of inservice teachers as well. Preparation and familiarity are critical for anyone to successfully adapt new innovations. Familiarity does not breed contempt; it breeds understanding and actualization.

Changing a Perspective

It is time that teacher educators and inservice trainers ceased training their students and faculty on antiquated architecture and under-powered software. ISTE's (1991) accreditation standards use the phrase "...be skilled in...". To be skilled in something means more than being able to write letters with word processors, use single table flat-field databases, and to do two variable operations on a spreadsheet. These skills cannot be honed or refined in a single course of study, particularly if the concept and application is introduced at this level. Opportunity and encouragement must be provided from all teacher educators to facilitate the development of competence and comfort with the software and hardware.

Professional Productivity

What is personal and professional productivity software? Perhaps it would be just as easy to talk about personal applications of hardware and software. Generally speaking, for the business world, a primary setup system would include communication, data analysis, information organizers, and graphic presentation software. This differs little for the educator. The educator needs tools that will help them to compile, synthesize, and utilize the information they gather on students. In addition, software should be utilized that helps the teacher organize present, and monitor instruction. This is the type of productivity software that the educator should become adept with and it is the type they should see modeled in their training. Without modeling the possibilities of students adapting, their use is lessened considerably (Johns, 1991).

Word Processors

Beyond a doubt, most of us understand the importance of using some type of a word processor. At the productivity level necessary in the education world a requirement is a full function, professional-class word processor. A professional-class is the choice of many because of all its *extras*. Not only is a professional-class word processor capable of the standard word processing activities, such as formatting, spell checking, and multiple types and fonts, it is also capable of a multitude of additional functions. For example, tables should be easily built, it should be able to produce multiple columns, and mathematical operations should be possible on columns of numbers. Additional functions include the ability to read database files for mail merging, building indexes and building tables of contents. Add to this a built-in thesaurus the capacity to work with windows into different sections of the same document or different documents at the same time, as well as the ability to directly import graphics and charts into the document and you really begin to get an idea of the full range of abilities of a professional-class word processor. Most of the major word processors available today are capable of performing these tasks. Unfortunately, reliance on antiquated or less than full-function word processors prevents our students from gaining experience and capability.

Spreadsheets

The analysis of data really takes place at two levels in the academic world (and business, as well). The first level is the need to organize and display numeric data; the second is the analysis of data. Operations at the first level also include the ability to create graphic representations of the data. For most teachers the use of an electronic spreadsheet will accomplish these first level activities. The spreadsheet allows the user to organize information as diverse as graderolls, test results, homework, and performance assessment. The user may also calculate summative scores for students, analyze test results, print graphics, maintain student records, review trends, etc.

Spreadsheets resemble electronic versions of an accountant's ledger sheet—empty rows and columns. The unfortunate part of the use of spreadsheets is that the user must design the input format and operations to be performed by the spreadsheet and this takes training and modeling by teacher educators. The newer, more powerful spreadsheets allow the user to link information contained on one spreadsheet to information contained on another. This linking action gives the user the capacity to literally build a relational spreadsheet, with each sheet (or page) containing its own information, but linked to related sheets or summary sheets, where the information is compiled for reporting.

Databases

The third element in a personal productivity package is the management of data or information through packages called database managers. The database manager may be no more complicated than an electronic cardfile or it may be as complicated as the retrieval system used in a library for literature searches. Businesses place more emphasis upon data management than most of us in education would, yet many of us maintain (or need to maintain) fairly detailed records — from student grades to mailing lists for support and advisory groups.

The purpose of the database is to present the information in some organized fashion. Flat-field databases are quite satisfactory for maintaining individual class information, but can get extremely difficult to handle if the file contains information for several classes and information about personal data of the students and their parents. A thorough database should permit easy entry of information, quick and comprehensive searches of information, the ability to print reports of subsets of the information, and the ability to export selected parts of the data to word processors for merging. Just a few years ago the use of relational databases seemed beyond the skill and fiscal ability of most educators. Today, the databases on the market are full-function, relational, and, relatively speaking, quite reasonable in their cost. A relational database permits the linking of related tables of data. Each element within the database may be linked to related information contained in other tables. Reports, summaries, or searches may be instituted through the use of the linking, thereby permitting the searcher to locate or summarize critical elements.

One of the strengths of the database system is the ability to select elements for exporting to a word processor. Through the use of the word processor's mail merge facility individual reports for each student can be printed. Using a full-function word processor also permits a graphic or picture to be imported to the word processor. As the database has grown in strength so has the ability to make use of its features for educators. The current movement in the evaluation field to utilize portfolio assessment is such an example. While several programs exist on the software market that purport to be portfolio packages, their current limitations outweigh their effectiveness. Yet, with the newer databases' capacity to store scanned information, it is within the ability of most educators to develop their own portfolio models.

Graphics Packages

The newest member of the productivity/information management team are the graphic presentation packages. There once was a time when a package such as *Printshop* was considered the extent of training a pre-service teacher needed in graphics. This is no longer true. Graphics presentation software, design software, and painting software provide the user many more opportunities today. The packages permit the user to create complex designs, to create electronic slide shows, to paste or export pictures to documents, etc. The use of a graphics package is limited only by the expectations of the user. However, if the user has never experienced the software, or never seen it utilized in a class or as part of instruction, then there are no expectations. The key to integrating the higher level skills provided the user through graphics packages is in their use and application by teacher educators.

Summary

The use of computers has come a long way in the last ten years. We know and acknowledge the word processor as a major change in our personal practices, but have yet to integrate the other elements of productivity beyond a superficial level. The scary part is that technology and software wait for no one. Two years from now the software that we call *state-of-the-art* will be *state-of-the-past*. The equipment we use today will be considered slow and outdated. While educators do not need to be the users of cutting edge technology, we must not allow ourselves to continue to use, or be satisfied with, out of date software and out of date equipment. Modern reporting and competency movements in education are beginning to demand that we maintain and make available all the information used to make decisions about our students. We will need to employ the technology available in order to add this duty to our already full schedule of duties and activities. This require additional training from teacher training institutes and additional modeling from teacher educators and in-service trainers. Without this training and modeling, teachers will simply fall victim to the information glut and will be unable to meet the demands placed upon them.

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Modeling instructional change using interactive multimedia in teacher training

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The central thesis of this paper is that interactive multimedia presents a unique opportunity to recast the teaching and learning process and, in so doing, provide an alternative paradigm to the traditional model. To facilitate this process, it is necessary that teacher educators be willing to experiment with this new technology in their own teaching efforts. Unless prospective teachers see such technology in action, they will be reluctant to incorporate it in their own classrooms. We believe that if teacher educators are willing to experiment and explore new technology, it will then have a trickle-down effect and eventually influence the teaching practices in our schools.

Spiro and Jehring (1990), in writing about hypertext, hold that "Traditional methods of instruction rely on linear media (e.g., textbooks and lectures)." The linear approach may be seen as a way of sequencing information in an order from a beginning point to an end point. Early content must precede later content in order for the relationships to be seen and understood. Generally, linear methods of instruction proceed in a step-by-step manner. The assumption of most linear approaches is that fundamental material needs to be understood by the learner before complex material can be explored. Traditionally, instruction has been linear because teachers were limited to speaking and reading formats that are linear by nature. Also, the linear approach brings an order that offers a sense of security for the teacher and the learner. This very security, however, has some disadvantages.

The major disadvantage of the linear approach is the rigidity it imposes on the learning environment. Dewey (1916), however, viewed education as the confrontation of problems. Problems, in fact, usually cannot be contained in a linear mode. Problems occur in a context of interrelated facts and events. In any context there is an interconnectedness of various events and forces. Good problem solving requires flexibility to explore many options. Rigidity limits options, while flexibility broadens options. In real life, most problems cannot be solved in a prescribed step-by-step fashion, nor can they be solved by merely consulting a textbook or notes from a lecture.

As we have pointed out, the linear model has been dominant in education because of our lack of a methodology to present information in modes that are not linear. With the advent of interactive multimedia, we now have ways of presenting information in different and more interactive manners. Interactive learning situations permit the student to be placed in an active role in the learning context. In the linear model, the learner is in a more passive and receptive role; the learner is to acquire the content in the prescribed order. In the interactive mode, the learner is able to explore relevant information sources much as a navigator traversing an unknown domain.

If technology is to change education, dramatic shifts in the way we conceptualize teaching and learning must take place. As pointed out in our introductory paragraph, our position is that if such dramatic shifts are to take place, they must begin at the level of teacher training. As teacher educators, we must realize that we can't teach the interactive paradigm through the linear paradigm. When we teach through the linear paradigm, we are essentially modeling the linear paradigm. If we want to model the interactive paradigm, we must teach through the interactive paradigm, Prospective teachers learn their craft in two ways. First, they must see examples by masters. Second, they must have the opportunity to use and experiment with different forms of pedagogy.

Many reasons can be identified that prevent us from modeling new technology and pedagogy like interactive multimedia. A primary reason is that it is hard for us to break out of our comfort zones, and our comfort zones tend to be rather linear. We must remember, however, that our students will face the same problem. The point is that the cycle must be broken somewhere, and that somewhere needs to be in the teacher training program. Another obstacle to integrating the interactive approach into our teacher training courses is the fact that the related technology is new.

This obstacle, however, can be overcome by simple honesty. We need to let the students share with us the experience of discovering new technology and new instructional designs. We have found that this works well. It creates an excitement and provides students with a teaching alternative that they can use in their own classrooms.

Let us suggest two major ways by which you can break the cycle of perpetuating the familiar. First, we view the foe of the interactive paradigm as the idea that "teaching is telling." We, therefore, ask our colleagues in teacher education to reframe the idea of teaching as essentially participatory. In the participatory mode, the lines between teaching and learning become more blurred. The difficult part of this is getting used to the idea that control does not have to reside with the teacher.

Second, we suggest the use of the case study as a way of approaching important concepts. The idea behind the case study is to involve students in a real life problem where there is not an immediate solution. Case studies invite student activity and can easily be translated into the interactive paradigm. In the case study approach, a classroom situation with a richness of variables approaching that of real life, can be presented. Students can generate hypothetical responses, test these responses against a dynamic representation of the case situation, revise their responses, further test, and thereby move through a learning matrix. In such a process, knowledge is acquired in a holistic, dynamic sense as opposed to being experienced as distant and inert. This approach lends itself very naturally to the use of interactive multimedia. Technology can be used as a way of presenting simulated experiences, and as a means of tracking and coordinating a dynamic learning process. Interactive multimedia offers us a unique moment to rethink the process of teaching and learning. Great changes in human endeavor never come as completed systems. Rather they offer those who are responsive the opportunity to experiment, explore, and lean.. We suggest that teacher training institutions be the first to sieze this opportunity.

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A permeated approach to technology in teacher education

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Introducing Technology to Intending Teachers

An effective introduction to technology for intending teachers recognizes the students' prior technological skills and perceptions; it then builds upon the students' existing needs and expectations, satisfying them but also modifying them as the students acquire competence and critical awareness—both as users of technology and as effective classroom teachers.

In an attempt to make technology more immediately relevant to intending teachers, some courses begin by focussing on applications rather than upon technicalities. Word processing has become a frequent starting point. It is attractive because it is immediately apparent to students that word processing can make them more effective communicators; thus they are motivated to gain some early technical competence. Word processing is also an application that has some obvious uses in the classroom; but it is important to recognize that, increasingly, students are entering teacher education courses already familiar with some aspects of technology. Some recruits have experienced word processing in earlier student days or, especially among mature students, in prior work experience (Blackmore 1992). It therefore becomes important to recognize a growing diversity of levels of entry skill. Increasingly too, students are likely now to have used other applications besides word processing as integral tools within the study of a subject or as occupational aids.

This diversity of applications must also be recognized and accommodated within teacher education courses. Lastly, it must be recognized that all students, no matter whether they have some prior computer experience or not, are intending to teach. Other than those who have an interest in teaching computing, the interests of intending teachers are firmly focussed on their own subjects rather than on technology.

Initial technology experiences for intending teachers should be ones which are appropriate for them. Word processing may be useful, but not all beginning teachers will see immediate uses beyond their own needs as students. Mathematics students might begin with spreadsheets; historians with databases; scientists with computation, data capture or control; geographers with remote sensing; modern language students with electronic communications; musicians with music packages and synthesizers; artists with imaging software; and so on. Through this approach, students can immediately identify the relevance of technology to their subject, both as students of the subject and, as they develop professionally, as teachers of it. If the focus is upon the relationship of the technology to the subject rather than upon the technology per se, then all students have something to learn, even those who may be already familiar with the application. Initial differences in technical competence between students become less marked as attention shifts away from technical matters to discussion about the nature of the subject and how it can be taught - something in which they are all beginners. Even for the nervous computer novice, technological fears and reservations are more likely to become suppressed and eradicated as attention shifts from technological to professional matters and to a realisation of the relevance and potential of this educational resource.

Applications like word processors and the other content free programs were not conceived as learning resources. They were designed as authentic tools for a variety of adult needs. While they perform specific functions, they may be used in a variety of contexts for a variety of purposes. Unlike more well defined computer learning programs, content free applications require the teacher to define the educational contexts in which such tools may be used and the functions for which they will be employed. For the inexperienced teacher, the applications provide considerable scope for where and how they might be used. Although this means that the software can sometimes be used to reinforce the unrefined practice of novice teachers, it does allow them to develop confidence and familiarity with the technology. Specifically designed educational packages offer the novice teacher more direct guidance, but, at the same time these computer learning packages can also offer a disconcerting mismatch for the inexperienced teacher between what that teacher wants and what the resource provides. Content free software challenges intending teachers to articulate their teaching objectives and methods and, of course, each student's use of the technology will be concurrent with the development of good practice, and so further use of content free applications can reflect and even highlight these changes.

Computer Learning Programs and Teacher Specialisms

Specific learning packages have an important place within the teacher education curriculum. Chosen with care, these packages can be used as vehicles to explore important epistemological and pedagogic aspects of the intending teacher's specialism. Indeed, when presenting software to intending teachers it is important to remember that when experienced teachers are introduced to new programs, they are just as much concerned to ask questions related to program content, teaching style, and classroom management as they are to consider the technical aspects of the resource. The computer experience has the potential to be a powerful stimulation for reflection on just what is important in teaching (Olson, 1988, p. 107).

It was apparent from the early days of educational computing that the computer could be useful for drill and practice wherever there was a corpus of knowledge or set of skills to be acquired. But even in those early days, practicing teachers rightly asked pertinent questions. As Rushby pointed out when such software first appeared (Rushby, 1979, p. 23) it makes a number of assumptions about the nature of the subject matter; in particular it assumes that a subject can be separated into small parts, each with clearly defined prerequisites and objectives so that the individual parts can be sensibly structured into a coherent sequence, also with clear prerequisites and objectives. That this is possible is more obvious for some subjects than for others. It also assumes that pupils conform to the behaviorist learning model. Again, it is not obvious that all of them respond to stimuli in the way that the theory assumes. The use of drill and practice software in the teacher education curriculum prompts discussion of conditioning as an effective method of learning and, if it is, which aspects of which curricular subjects can be presented to which children in this way.

Later software developments were also to require teachers to attend to questions of subject matter and teaching methodology. The use of computers to teach school subjects through simulating the problems and modelling the processes teachers of the subject conventionally deal with is a useful way to represent the nature of the subject as well as a way to help students understand the way the subject "works" (Olson, 1988, p. 61) This in itself is useful to intending teachers. But, in addition, the advent of computer simulation and model building requires appreciation of a further theory of learning based on the concepts of developmental psychology. The major premise is that knowledge can be created through the child's experiences so the emphasis is upon the pupil's exploration of information on a particular topic. The computer is programmed to allow children to explore ready built models or build their own and so to learn by discovery. For teachers, this poses new challenges. Exploration is far less prescribed than traditional teaching. It must be more flexible and open ended. It is more time consuming and collaborative in nature. The software raises further questions to be answered concerning relevant subject applications: the underlying pedagogy and practical management in the classroom.

If student teachers are to be introduced to appropriate software for the teaching of their chosen subjects and age phases, it is important to recognize that they, even more than experienced teachers, will have questions to ask and problems to face. It is likely that student teachers will lack the experience and perhaps the confidence of experienced teachers to ask questions. They may not even be able to articulate their questions about the use of individual programs or technology in general. It is important to enable and encourage them to do so. A failure to create such possibilities could lead to confusion and uncertainty about the educational use of technology. It might even lead to rejection of it. It certainly will not help teachers become professionally critical about educational technology. A recognition of the issues, on the other hand, opens the door not only to a greater understanding of the educational potential of technology but also of the teaching process itself.

Technology and the Wider Professional Education of Teachers

Much of what has been discussed so far about the way that technology might be presented in teacher education will help intending teachers to look inward, illuminating their specialist teaching. But while a teacher might have an allegiance to a particular specialism, there is the whole curriculum to consider and aspects of cohesion, continuity and progression to address. This is no less the case with the curricular application of computers. Technology can be a useful vehicle for the discussion of these and also of other wider pedagogic issues, aspects of professional knowledge and skill that are fundamental and common to all teachers and that form a common core in the teacher education curriculum.

Consider for example the way that different teachers use some content free applications. Intending language teachers might find the text processing power of a desktop publishing program particularly attractive and educationally valuable in their subject. Teachers in other subjects might wish to present the software differently - for example, in subjects where visual communication is particularly important it, might be useful to concentrate first on the graphic potential of the package. Consider, too, how databases may be used differently in each curriculum subject. Which aspects of which subjects may be "represented" in a database? What sort of interactions with the subject must pupils undertake to construct or interrogate a database? An awareness of such differentiation can be the start of a fruitful dialogue between teachers enabling them to appreciate better the commonalities and differences of their respective subjects. It can also contribute towards their vision of the whole curriculum and the place of technology within it.

Such debate is concerned not only with subject content but also with teaching style. To take word processing and desktop publishing again, the way in which one teacher enables children to use this in the classroom is often totally different to that of another. Content free applications are adaptable enough to fit many teaching patterns. They can reinforce bad practice as well as good practice. Word processing can allow children to engage more fully in authentic writing activity - drafting and redrafting their work, paying attention to content and form; collaborating in a group with others; presenting attractively produced final copy. It can also be used as nothing more than a glorified typewriter, a reward for the individual child who has already laboriously hand written on his or her own the first and only version of an essay. More prescriptive learning packages prompt a consideration of the discrepancies between the teaching style they embody and the methodology considered valuable by the teacher. Content free software requires teachers to use their own teaching styles, so the comparison is between different teachers using the same software rather than between software and teacher.

For intending teachers, it can be immensely valuable to discuss how they would use the same software in their respective lessons. Between students of the same subject or age phase and between students of different age and subject specialisms, a discussion centered around such computer use can be a stimulus to a greater understanding of their own subject and teaching style and also of the range of subject functions across the curriculum and the range of teaching styles available and in use.

There are other ways in which computers can highlight wider pedagogic issues. Consider, for example, the linguistic and cognitive dimensions of the teacher education curriculum. The teaching of language skills is seen to be a responsibility of all teachers, regardless of their subject and the age phase of their pupils (CATE, 1992, p. 10). But language is also the major vehicle for teaching and learning in schools. Learning, it is now clear (Marland, 1977, p. ix), involves language not merely as a passive medium for receiving instruction, but as the essential means of forming and handling central concepts. Thus, learning is not merely through language but with language. Therefore, the development of a technology designed precisely to store, sort, search, and transmit huge amounts of information at high speed in efficient and often novel ways is potentially of great relevance to teachers and pupils (DES, 1988, para. 14.17).

The very design of a word processor reveals much about the nature of writing which should be of professional interest to intending teachers. An exploration of the way that children use a word processor reveals more to teachers about the way that children think and write. When children are seen word processing in groups, the exercise provides insights into ways in which language can be a vehicle for learning; the way that children collaborate; alternative strategies for classroom organization and new roles for the teacher.

The study of databases can be used to focus on other important areas of the teacher education curriculum. Despite the fact that information skills are central to the educational process and that they are being introduced into schools as part of a drive towards greater learner autonomy, many of the concepts and skills involved in handling information and in fulfilling a task are frequently as novel to teachers as they are to pupils. Carter and Monaco (1987, p. 7) claim that pupils of all ages and abilities, together with many teachers, lack an appreciation and understanding of the concepts underlying what they do. The use of databases calls into question and makes explicit the types of knowledge, understanding, and information handling skills required of pupils. As is so often the case with the new technologies, the skills demanded of database users, especially children, are of a high order, and sometimes very different from those typically required in school activities. To interrogate a database, children need to form and test hypotheses, formulate precise questions and apply logical operators, evaluate results, look for relationships and classify and categorise information. This takes place within a specific discipline framework which often determines the precise nature of the concepts, skills and data employed. The construction of a database requires many of the same skills. It requires a thorough knowledge of the subject to be represented - its factual detail, its overall conceptual and structural framework, and its internal relations. It requires a critical ability to determine what is important factually and conceptually to future users of the database and the methods (often subject specific) which will be used for subsequent interrogation.

Teachers can hardly be expected to help their pupils cope successfully with information skills until they themselves have had the opportunity to learn them. Intending teachers therefore need not only to acquire the skills of information handling but also to understand fully the underlying concepts. Carter and Monaco (1987, p. 7) claim from their research that the use of technology for communicating information appears to offer a potent way of demonstrating many of the concepts pupils and teachers find so difficult to grasp.

Information is common to all subjects, and thus it can be argued that skills to handle information should be applicable to all subjects. However, knowledge is compartmentalised into discrete areas so it is hardly surprising that pupils frequently fail to see the connection between subjects and are unable to transfer knowledge or skills learned in one subject area to that of another. On teacher training courses, the trainers could help by using technology to demonstrate the links between subjects and their importance, something that teachers need to take account of in their own teaching (Carter, 1988, pp. 11-12). Training is also needed to help teachers to be flexible in their approach to classroom management and to possess a range of teaching styles. Such flexibility will include the ability to know when to "back away" and leave the pupils to take full command of the task and any technology involved.

Other types of software are also useful vehicles for the consideration of fundamental educational issues. Logo stands out as an obvious example. When he designed LOGO, Papert was, of course, greatly influenced by the work of Jean Piaget.

> (The computer) is not just another powerful educational tool. It is unique in providing us with the means for addressing what Piaget and many others see as the obstacle which is overcome in the passage from child to adult thinking. I believe that it can allow us to shift the boundary separating concrete and formal. Knowledge that was accessible only through formal processes can now be approached concretely. (Papert, 1980, p. 21).

Children working with LOGO provide useful exemplars, whereby intending teachers can examine important psychological theories of the way that children think and learn. That learning, Papert argues, is greatly assisted by the way in which computer models seem to be able to give concrete forms to areas of knowledge that had previously appeared so intangible and abstract. In so doing, computers offer children very concrete models to think about thinking and to learn about learning enhancing their powers as psychologists and as epistemologists. (Papert, 1980, p. 23)

As this paper has attempted to indicate, there are many opportunities whereby the computer can provide valuable insights into epistemological and psychological issues. The advantage in the case of LOGO is that Papert has not only provided an exemplar of a theory in practice, but he has also furnished a substantial rationale. Because he draws upon and challenges the theories of Piaget concerning cognitive development, he provides a very accessible approach to one of the central figures in contemporary educational psychology.

Papert posits a further hypothesis with implications for the content and design of teacher education programs. Some of the most important work in psychological theory is currently being undertaken in artificial intelligence. In order to expand the capacity of machines to perform intelligent human functions, it is usually necessary to reflect not only on the nature of the machines but on the nature of the intelligent functions to be performed.

O'Shea (1983, p. 4) points out that artificial intelligence programs are often involved with processes such as remembering and accessing relevant knowledge: using this knowledge appropriately (for example to reason and to form plans of action); revising and extending knowledge; searching in some more or less systematic way for a solution to a problem; recognising similarities and drawing analogies between things; and finally, attempting to understand some aspect of the surroundings (for example, something communicated to computers in English). In principle, therefore, artificial intelligence should be relevant to the design of teaching and learning systems since these processes are generalizations of particular teaching and learning activities (O'Shea, 1983, p. 4). The ways by which good organizations in a computer are developed suggest guidelines and insights into how learning environments might lead to the development of good organizations of knowledge in a child's brain. In the not too distant future, it may well be that theoretical work in this field will need to impinge upon the content of teacher education courses, and that the technology itself will have far more to present to intending teachers about teaching and learning processes.

While computer scientists are designing ever more sophisticated machines to replicate what is going on in the human mind, it is also true that the machines are making far greater cognitive demands than ever before. In "Mindstorms", Papert discusses ways in which computers might change thinking and ways in which learning might take place. It is a large subject looking not only at the psychology of learning but at the role of the teacher and the very function and existence of schools in the future. It draws in the sociology of education as much as its psychology and, thus, brings into discussion very important questions for all intending teachers to consider. Even now, however, integrating computers into the classroom is more than simply assimilating the technology into existing classroom practices. The very goals of these practices are brought into question because using the computer as a teaching aid itself raises questions (Olson, 1988, p. 53). Using technology in the classroom becomes an occasion for reflecting upon the curriculum itself and whether or not the computer offers opportunities not yet embodied in the curriculum.

Such questions take us a long way from the content of courses which concentrate on the teaching of operational skills, but these dimensions are essential elements of the technology curriculum for intending teachers if those teachers are to develop a critical framework within which to think about how computers can be used effectively in the classroom. Indeed, it can be argued that it is not until teachers have fully explored these dimensions that they will ever make really effective use of technology in their teaching.

The computer is not just a powerful teaching resource for use in schools and should not be used with intending teachers only in this way. It is an instrument which can be used in the broad professional development of teachers, focussing attention on fundamental epistemological and pedagogic issues related to the intending teacher's chosen age and subject specialism, to cross curricular and age phase matters and to wider concerns which lie at the heart of any teacher education program. If the technology is developed in context and integrated with other learning as part of the teacher education course, then intending teachers are offered a powerful learning process. It encompasses the prior technological skills and perceptions of students; it builds upon the perceived needs of students, and it leads on to wider professional development, offering in the process a curriculum led model of how to integrate computers into teaching in schools.

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The implementation of computer technology in preservice teaching

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Introduction

Preservice teachers need to perceive computers as integral parts of the instructional strategies and professional activities of teachers. Teacher education programs must build upon the existing computer experience of all preservice teachers and introduce them to the wealth of resources, new instructional strategies, and sophisticated laboratory and simulation tools made possible by the emerging technologies, such technologies permit the attainment of learning goals beyond the capabilities of traditional instructional modes. Like many educational training institutions, the University of British Columbia (UBC) is attempting to respond to the perceived technology needs of its preservice teachers. Secondary teacher education at UBC consists of a twelve month, post baccalaureate program combining elements of curriculum and educational theory with a thirteen week, school-based practicum in the winter term. The design of the program gives the students little opportunity to select elective computer/technology courses. Furthermore, the students who fit such courses into their program can generally do so only in the summer term after they have completed their practicum. These circumstances lead to the dilemma of how to adequately prepare the students to utilize computer-based technology. Clearly, some training elements must be included in their first term of work, but how and which elements? Other elements could be offered after the practicum, but would the students perceive the need for such training? In order to address these problems, a three year study of the implementation of computer technology by preservice teachers in their practicum experience was begun in the spring of 1992. The specific objectives of this study were to (a) assess the actual use of computers by the students, (b) sample the students' perceptions about their preparation to use computers during their practicum, and (c) identify program areas in need of technology-based revision. The underlying purpose of the study was the isolation of patterns of computer use and the development of procedures among UBC's Faculty of Education to encourage and facilitate effective educational use of computer-based technology both in the teacher education program itself and in the classroom.

Methodology

At the beginning of the summer term in 1992, UBC's secondary preservice teachers were asked to complete a questionnaire designed to sample (a) their use of computers during their just completed practicum, (b) their perceptions about their levels of preparation to use computers during the practicum, and (c) their attitudes towards the classroom implementation of computers. The first section of the questionnaire was used to gather minimal demographic data. In the second section, the preservice teachers' use of word processors, graphics programs, spreadsheets, and database applications was surveyed. For each of these applications, the students were asked whether or not they had used it during the practicum and what they felt their level of preparation to use the application had been. Those students who indicated that they had used the application responded to a further set of questions which probed the nature and extent of that use. For completeness, the students were also asked to indicate whether or not they had used any other computer application during the practicum, such as Hypercard, a MIDI program or a computer-based lab.

In the final section of the questionnaire, the students were asked to record their levels of agreement or disagreement to a series of statements related to attitudes toward the use of computers. This section was included to explore the interaction between attitudes toward computers and the adoption of computers as professional and instructional tools. Three attitude dimensions were sampled using items from Loyd and Gressard's (1986) *Computer Attitude Scale*. These attitudes were Computer Liking, Computer Usefulness, and Computer Anxiety In addition, the participants were asked to respond to five specific questions related to the educational implementation of computers.

The questionnaire was administered at the end of a required class during the first week of the summer term. One hundred fifty-one students completed the questionnaire. Nine of the returned questionnaires were unusable and 37 of the respondents indicated that they had not used computers during their practicum. The responses received from the remaining 105 students comprise the basis of the results presented in this paper. Data were gathered from 51 females and 47 males. Seven did not report their gender.

Computer Training

The 105 students were divided into 8 groups according to their teaching subject. This process resulted in 14 students being included in 2 groups and was done in order to facilitate the assessment of the partially discipline-based, teacher education program. The 8 groups were Technology Education (TCED), Business Education (BUED), Home Economics Education (HMED), Foreign Language (FRNL), English (ENGL), Math and Science Education (MSED), Social Studies Education (SSED), and Art and Music Education (AEME). The students were asked to indicate their general level of computer experience prior to the practicum on the following 4-point scale:

1 - *zero experience*
2 - *not enough to feel comfortable using a computer*
3 - *enough to feel comfortable using a computer*, and
4 - *extensive*.

The findings are summarized in Table 1. The responses indicated that the majority of the students had moderate computer experience - a fact that probably engendered their use of computers during the practicum. The greatest experience was reported by the TCED students followed by the MSED students. The least experience was reported by the HMED students, but those of the FRNL, ENGL, SSED and AEME students were all below optimal standards for instructional applications. The percentages of the students in each group which had received specific types of training are shown in Table 1. The most widely trained students were the TCED students, all of whom reported having had word processing training, with most also having both graphics training and training to use computers within their specific discipline. Word processing training was the most common form of training received by all the other student groups except for the BUED students for whom business data processing training exceeded word processing

Table 1
Summary of the Pre-practicum Computer Experience and Training of the Preservice Teachers

Group	No.	General Exp.	Word Proc.	Discipline Use	Data Proc.	Prog.	Graphics
TCED	13	3.62	100%	77%	23%	38%	92%
BUED	9	3.00	56%	44%	67%	22%	11%
HMED	8	2.50	88%	13%	0%	0%	13%
FRNL	12	2.75	75%	8%	33%	0%	17%
ENGL	18	2.72	67%	22%	11%	6%	6%
MSED	29	3.24	86%	41%	24%	52%	24%
SSED	21	2.81	67%	24%	14%	24%	19%
AEME	9	2.78	67%	56%	11%	11%	33%
Total	105	2.93	76%	36%	23%	19%	27%

training. Programming training was almost exclusively restricted to the MSED students.

With the exception of the TCED students, roughly two thirds of the students in every discipline group indicated that their computer training was self taught. This result reflects the reality of UBC's post baccalaureate teacher education program and emphasizes a problem that the program must resolve. The TCED students comprise a special group of students who gain entrance to the teacher education program by completing a specific program of studies at a local technical institute affiliated with the university. This program is specifically designed to meet the needs of teachers and includes mandatory computer training. As a result of this program, all the TCED students enter teacher education with a strong background in computers. All other students gain entrance to the teacher education program on the basis of their university degrees, and, while these students have to meet certain academic course requirements, computer training is not one of them. The computer background of these students, accordingly, is highly eclectic and largely self-taught. The teacher education program must be flexible and responsive to meet the changing and variable needs of these students.

One perennial concern of preservice teachers is the availability of computers in the schools. In reality, however, this concern is specious. The students reported that computers were readily available for their use at all times although computer labs generally had to be prebooked for class use. While it would be nice to conclude that this result indicated a wealth of computer resources in the schools, in fact, it reflects instead the minimal use of existing facilities and reinforces the need for both preservice and inservice training of teachers to implement computer-based technology more fully. All of the TCED students, and the majority of the other students reported that their home computer was the one most used during the practicum. Only the BUED and SSED students indicated a slightly higher use of school computers (56% and 52%) than home computers (44% and 43%). IBM and clone machines were used by 75% of the students and Macintosh computers, by 28%.

Use of Specific Applications

Table 2 summarizes the preservice teachers use of word processors, graphics applications, spread sheets, databases. and other computer applications. By far, the most used application was word processing, with roughly only a third of the students making even minimal use of other applications. All of the student groups indicated that their preparation to use a word processor application was "enough to feel comfortable using one" but only the TCED and AEME students reported feeling comfortable using graphics applications, and only the TCED and BUED students felt comfortable using spreadsheets. None of the student groups felt prepared to use database applications. Some subject-related patterns in the use of computers are suggested by the data in Table 2. The TCED students were the highest overall users of computers during the practicum. The implication of this finding is that sound computer training results in broad-based educational use. Training was also inferred to be the basis of the relatively high use of computers by the BUED and the MSED students. The low rate of use of any application other than a word processor by all of the humanity students is a cause for some concern and may suggest an important area for program revision.

Within each of the applications areas, patterns of computer use were evident. The highest reported use of word processors was to prepare student exams. All of the groups, except the AEME students, reported using the computer to prepare exams 70% to 90% of the time. The next most frequent use of word processors was to prepare student quizzes and worksheets or handouts. The use of word processors as a basis of student assignments was generally very low (≤30%) with the greatest frequency

Table 2
The Frequency of Use and Preparation to Use Specific Computer Applications

	Word Proc.		Graphics		Spreadsheets		Databases		Other
	Use	Prep.	Use	Prep.	Use	Prep.	Use	Prep.	Use
TCED	100%	3.69	85%	3.73	62%	2.88	62%	2.38	92%
BUED	100%	3.11	22%	2.50	78%	3.00	11%	1.0	33%
HMED	63%	2.80	25%	2.00	25%	2.00	38%	1.33	13%
FRNL	83%	3.10	33%	2.50	33%	2.50	25%	2.33	17%
ENGL	100%	2.72	11%	1.50	6%	2.00	28%	2.40	6%
MSED	97%	3.36	24%	2.57	41%	2.50	55%	2.00	21%
SSED	90%	2.74	10%	2.50	19%	2.50	43%	2.00	19%
AEME	100%	3.00	22%	3.00	0%	0.00	11%	2.00	22%
Total	92%	3.06	29%	2.54	33%	2.17	34%	1.93	28%

Table 3
Preservice Teacher Attitudes Toward Educational Computer Utilization and Training

	Anxiety	Liking	Useful	1	2	3	4	5
TCED	3.30	3.47	3.80	3.34	3.59	3.49	3.31	3.23
BUED	3.31	2.99	3.81	3.44	3.89	3.33	3.67	3.56
HMED	2.80	2.70	3.31	3.00	3.38	3.25	2.88	2.63
FRNL	3.08	2.78	3.35	3.67	3.42	3.42	3.33	3.17
ENGL	3.08	2.83	3.48	3.28	3.78	3.56	3.28	2.89
MSED	3.40	3.21	3.59	3.45	3.48	3.38	3.14	3.35
SSED	3.22	3.00	3.58	3.33	3.76	3.76	3.52	3.33
AEME	3.22	3.09	3.48	3.22	3.33	3.22	3.33	2.78
Total	3.18	3.01	3.55	3.34	3.58	3.43	3.31	3.12

Statements

1. The effort necessary to integrate computers into my teaching is an efficient use of my time.
2. I think that teacher training should include instructional applications of computers.
3. Eventually, all teachers will need to be able to use computers.
4. I expect to have a lot of use for computers in my classroom.
5. I will use computers many ways in my teaching.

being reported by the BUED students. Lesson plans, unit plans and transparencies were prepared on the computer less than 30% of the time. Of the students who reported using spreadsheets, almost the only utilization was to accumulate student marks. Similarly, databases were used almost exclusively to enter report card grades - a process that was mandatory in the largest school district in which the student teachers were placed for their practicum. CAD programs were used by 12 of the 13 TCED students during the practicum but other applications, such as Hypercard, computer-based simulations and labs, and MIDI programs were each used by only one or two students.

Attitudes Toward Computer Utilization

Table 3 summarizes the mean scores, on a 4-point Likert scale, for the attitudes of Anxiety, Liking, and Usefulness, and the responses to five questions related to the need for training and projected computer use. As the data in this table indicate, the preservice teacher attitudes toward the utilization of computers was found to be generally positive but with some variation indicated among the subject-related subgroups. The Anxiety and Liking mean scores of the HMED, FRNL and ENGL students were significantly below the average means but all the groups rated the usefulness of computers very high. The attitude mean scores for the entire group of 105 students were comparable to those that Hunt & Bohlin (1992) reported for a similar student population.

All subject area students were in strong agreement that the instructional uses of computers should be included in the education of teachers. All of these students had some computer experience and, following their practicum, were apparently ready for, and perceived the need for, additional, specialized training. All of the students felt that the integration of computers into their teaching was an efficient use of their time and foresaw a time when computers would be essential tools for all teachers. Examining the responses to these five statements by subject area indicated that the HMED students appear to have the least understanding or appreciation of the computer's potential value as an instructional aid. One seemingly anomalous finding of the study was that, although the MSED students were the least anxious about using computers, they were next lowest to the HMED students in their expectations of having a lot of use for computers in the classroom. The MSED students, did, however, express a high expectation of having many personal uses of computers.

The responses to individual items on the attitude survey that are especially relevant to the efficacy of teacher education programs were selected for detailed group analysis. These items, summarized in Table 4, relate to feelings about taking computer classes, the need for instructional training , and attitudes toward the use of computers in education. The responses obtained for statements 1, 2, 6 and 7 in Table 4 are significantly different from those obtained by Hunt and Bohlin (1992) for their sample of preservice teachers enrolled in an educational computing course, while the responses on statements 3, 4 and 5 are similar. Both groups were highly motivated toward achievement in computer courses and felt that mastery of computers would be essential in getting and maintaining a teaching position. However,

Table 4
Frequencies of Student Responses to Selected Statements

Statement	SA	A	D	SD
1	56	39	7	3
2	35	48	18	4
3	70	31	3	1
4	39	49	14	3
5	73	25	6	1
6	2	0	17	86
7	4	2	37	62
8	5	7	40	53
9	70	27	5	3
10	61	35	7	2
11	3	7	44	51
12	41	50	9	5

Note. Statements 8-12 are listed in Table 3

Statements
1. It wouldn't bother me at all to take computer courses.
2. I would feel at ease in a computer class.3. It is important to me to do well in computer classes.
4. I'll need a firm mastery of computers for my future work.
5. Knowing how to work with computers will increase my job possibilities.
6. I can't think of any way that I will use computers in my career.
7. Working with computers will not be important to me in my life's work.

while Hunt and Bohlin's (1992) students expressed anxiety toward taking computer courses and an apparent lack of understanding of the computer's potential value as an instructional aid, the students in the present study felt at ease with the idea of taking computer courses and appeared to appreciate the educational potential of computers.

Key Findings and Instructional Implications

1. The students began their practicum with a wide range of computer experience and training.
2. All of the students felt comfortable in their ability to use a word processor but the range of utilizing them was narrow.
3. The training in and use of applications other than word processors was low (~ 30%).
4. None of the students felt prepared to use database applications such as test generators and data banks.
5. The students could all have profited from seeing models of professional applications of generic computer software to produce unit and lesson plans, locate resource materials, to record student grades and to generate exams from test-item banks.
6. The computer training required of the TCED students appeared to result in a high level of computer use during their practicum—both as a professional tool and as an instructional tool.
7. The computer preparation of the HMED and all the humanity students was very meager resulting in little use of computers other than as a word processor to prepare exams and worksheets. These students would be particularly well served by more basic computer training prior to their practicum.
8. The frequency of having had computer training in the specific teaching disciplines was minimal and that of using computers for instructional purposes was almost zero. Only the TCED and BUED students appeared to have had training in subject-specific applications but few of even these students used these applications in the classroom. This finding indicates a strong need for methods instructors in all subjects to begin to introduce and model computer applications specific to their own discipline areas.
9. Although the students' use of computers during the practicum was not extensive, their attitudes toward the need for further computer training upon completion of the practicum were very positive. It would seem to be important, therefore, to give all preservice teachers enough computer training prior to their practicum to be able to use computers in some manner while in the school. This experience may be instrumental in overcoming fears toward the utilization of computers and demonstrate their potential as professional and instructional tools.

10. The students returned from their practicum with the strongly held view that teacher training should include preparation in the instructional use of computers and that such use of computers would be an efficient use of their time. These two findings suggest that while some modeling of instructional uses of computers should precede the practicum, post-practicum training in computer-based instructional strategies might be instrumental in promoting the full integration of technology and education.

Conclusion

An objective of introducing computer-based technology into education is to change, and, hopefully, to improve the pedagogical process and product. Preservice teachers must perceive computers as integral parts of the instructional strategies and professional activities of teachers and become committed to their use. The modest degree of preparation of the majority of the students included in this study appeared to be sufficient to encourage them to use computers as personal tools during their practicum. Many of them returned to the campus wanting to improve their computing skills. However, few of the students used the computer as an instructional or student-learning tool. This result is attributed to the general lack of training or modeling in this area. In addition to basic computer preparation, preservice teachers need to be taught how to get students to use computers as production and learning tools, and how to integrate the computer and related technologies into the instructional strategies relevant to the various subject areas. At the secondary level, methods courses provide a particularly well-suited environment for the pre-practicum modeling of computer-based instruction. Such courses are generally subject-specific and form the core of most teacher education programs. Post-practicum training in instructional technologies should also be subject-specific, essentially advanced methods courses in which preservice teachers are introduced to the technologies and related resources most appropriate to their specific teaching fields. Within such courses, it would be possible to utilize a computer-based, instructional methodology similar to the one that preservice teachers will be expected to later use and to show how to adapt or develop curriculum to integrate computers and related technology.

The need to more fully integrate technology into teacher education is currently being addressed by revisions to structure of UBC's teacher education program. A basic computer applications course and a general course in educational uses of computers are available as electives both before or after the practicum semester. In addition, computer-based instructional technology courses in Science, Art, Music, English and Foreign Languages have been established as electives in the third term. Students can also elect one of several programming courses, including one based upon Hypercard. As resources permit, the goal is to provide all preservice teachers with an education that integrates teaching with computers and related technologies.

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Computer education for teachers: Advocacy is admirable but role modeling rules

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Introduction

The inevitability of computers in society presents all educators with enormous challenge and opportunity. The challenge is to educate for a future in a technology centred information age - the opportunity is to apply technology to revolutionize the process of education. Integrating computers and related technologies into the teaching learning environment, however, is challenging and teachers must be well prepared to meet this objective. But what does the prospective teacher need to know about computering technology and how best can this knowing be accomplished about? After presenting contemporary opinion on the goals, nature, and content of computer education for teachers, this paper will focus on the importance of advocacy and role modeling in the integration of computers into the teaching/learning environment. As a consequence of direct experiences with the teacher preparation programme at Canada's second largest university, this presentation will illuminate specific examples of how teachers and teacher trainers can successfully integrate computers into classroom learning and role model the use of computers in teaching.

The Nature and Content of Computer Education for Teachers

Goals of computer education

Much has been written on this topic. Recently, Bitter and Yohe (1989) asserted that a teacher's knowledge about technology must go beyond the hands-on experiences to an understanding of the conceptual; and they defined the broad goals of computer literacy education as follows:

1) teachers must be proficient, critical users of current educational technologies, including recognition of their limitations and future possibilities.
2) teachers need a broad education in order to determine the applications of changes and innovations in technology from more than one perspective.
3) teachers must be competent designers of instructional systems which will enable them to assist their students to become critical thinkers.

These authors correctly note that concepts change less rapidly than technical knowledge. By contrast, Davis (1992) relates four key recommendations of a United Kingdom government-sponsored working group which have been incorporated within the criteria for teacher accreditation. Stated in the form of the outcomes of teacher training, these four are that students (i.e. pre-service teachers) should be able to:

1) make confident use of a range of software packages and information technology devices appropriate to their subject specialism and age range;
2) review critically the relevance of software packages and information technology devices appropriate to their subject specialism and age range and judge the potential value of these in the classroom;
3) make constructive use of information technology in their teaching and in particular prepare and put into effect schemes of work incorporating appropriate uses of information technology;

4) evaluate the ways in which the use of information technology changes the nature of teaching and learning.

Guiding principles for teacher training

In a fairly recent study of computer literacy education programs for teachers, Taylor (1988) identified five recurring maxims which he advocated should be kept in mind during the design of computer literacy education programs for teachers. These maxims are:

1) make sure the analogic leap required of the trainees is of a type and size they are capable of making.
2) don't give up on teaching programming just because so far it has not worked too well.
3) train trainees as you want them in their turn to train their students.
4) use technology in a myriad of ways in the training course.
5) capitalize on the opportunity technology presents to make changes where appropriate in the curriculum.

The content of computer education

A spectrum of opinion exists on the content of computer literacy education for teachers. In attempting to define the specifics of a curriculum, Troyer (1988) studied forty-three sources containing recommendations for the content of computer education for teachers in a search for commonalities. The six most frequently mentioned topics were:

1) computer operation and structure
2) educational applications of computers
3) software/courseware evaluation
4) impact of computers on society and education
5) applications packages (word processor, database, and spreadsheet)
6) elements of programming (reading and writing simple programs)

In light of the evolving importance of access to information in society, Spielvogel (1988) appropriately recommends the inclusion of a component on telecommunications. In contrast, the interest and emphasis placed on programming has declined.

The delivery of computer education

Heidt and Poirot (1988) recommend that computer courses for teachers be taught by those who are appropriately qualified. In the case of the computing science teacher, appropriate qualification is seen to imply pre-college teaching experience. In the case of education faculty, formal work in computer education and demonstrated experience with the use of the computer as an educational tool are suggested.

Not surprisingly, consensus of informed opinion favours a hands-on approach to the achievement of computer literacy. Watt (1988) captures this sentiment in citing the ancient wisdom: "I hear and I forget, I see and I remember, I do and I understand."

A Perspective from the University of Alberta

With approximately 25,000 students, the University of Alberta is Canada's second largest university. At any point in time, there are about 4,000 students registered in its Faculty of Education. In 1986, the University of Alberta acknowledged the importance of computers to education by requiring all future graduates from its Bachelor of Education program to include at least one three-credit computer course in their programs; "Introduction to Microcomputers in Education" (IME), offered by the Faculty of Education, is one of two courses through which this requirement is typically met. Reflecting many of the characteristics of computer literacy education for teachers presented earlier, this course is at the introductory level, is practically oriented, reflects applications (rather than programming), and features two types of computer. The overriding objective is that students have a positive and successful first experience with the computer—being able to do something with the computer is a primary outcome. The achievement of this outcome is guided by what is considered by the author to be one of the most eloquent, timeless, yet concise definitions of computer literacy, notably that "computer literacy is a contact with the activity of computing deep enough to make the computational equivalent of reading and writing fluent and enjoyable" (Kay, 1984). The course includes lecture time and lab time, covering the following topics:

- computers use in the schools
- educational applications of computers
- what is a computer system?
- the operating system - what it is and what it does
- historical development of the computer
- evaluation of courseware
- morals and ethics of computer use

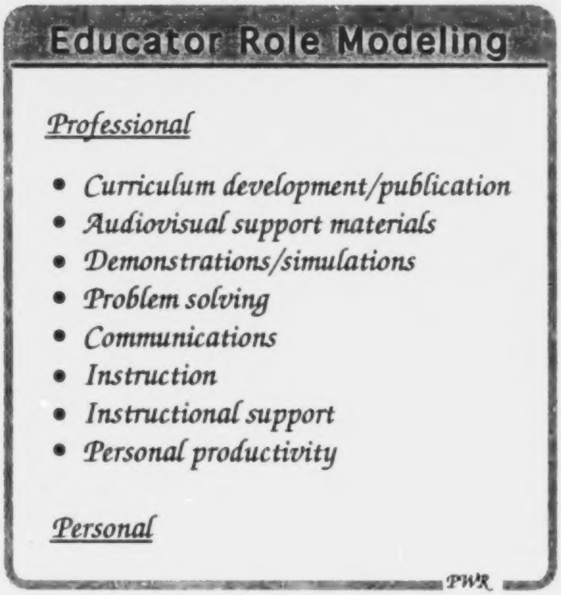
- computer applications I - computer as a tool (problemsolving/productivity)
- computer applications II - other applications (including CBI)
- access to information & telecommunications

Upon completion of IME or an approved equivalent, students can choose from a variety of targeted courses including a natural sequel to IME called "Application of Microcomputers in Education" (AME). AME provides students with a hands-on opportunity to explore the instructional potential of desktop publishing and sophisticated authoring tools such as hypermedia and authoring systems. The delivery of IME and AME strongly subscribe to the philosophy that faculty involved with the delivery of computer education should role model the effective use of the technology.

Advocating and Role Modeling the Use of Computers

Rationale for, and meaning of, advocacy and role modeling

There is a growing concensus that the integration of information technology into the teaching/learning environment can be addressed through advocating and role modeling the use of technology during the delivery of computer education to teachers. But what is meant by advocacy and role modeling? Advocacy implies showing others how technology can be applied to advantage in their teaching; role modeling, by contrast, is using technology to achieve this objective as well as demonstrating the personal and professional benefit to be derived from its use. Defined this way, the desirability and importance of advocacy and role modeling seems self-evident. This sentiment has been captured by a number of observers including Gooler (1989) who makes



Educator Role Modeling

Professional

- *Curriculum development/publication*
- *Audiovisual support materials*
- *Demonstrations/simulations*
- *Problem solving*
- *Communications*
- *Instruction*
- *Instructional support*
- *Personal productivity*

Personal

Figure 1
Role modeling of computer use by educators

the point that "intuitively, it seems obvious that teachers will use technologies only to the extent that they are familiar and comfortable with the technologies." He goes on to undercsore the importance of role modeling by stating that "the initial mindsets and comfort level of the new teacher are formed during the undergraduate experience, and may be carried over to the professional life of the teacher." In the past, leaders in educational computing have been very good at espousing and even mandating the integration of computers into teaching and learning but less effective at bringing it about.

Examples of advocacy and role modeling

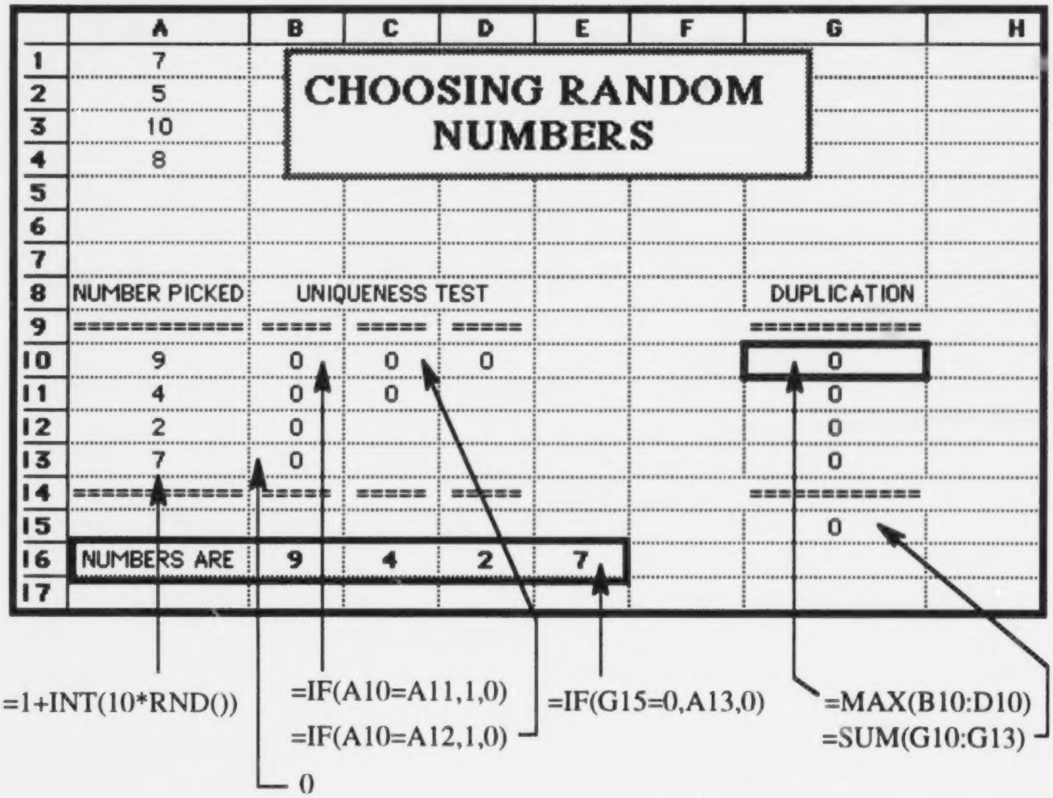
Role modeling and advocacy of computer use can occur in both the professional and personal domains and while the fact that the use of computers in personal life is in itself a strong indicator of advocacy, this paper emphasizes professional role modeling.

Some of the ways in which a teacher educator can role model the use of computers and related technologies are shown in Figure 1. For the purpose of discussion, the term educator is used in an inclusive manner.

Curriculum development, publication, and audiovisual support materials. One of the most natural ways in which a teacher educator can role model the use of information technology is through the development of instructional resources. The IME course described earlier is supported almost exclusively by instructor developed resources including tutorials, audiovisuals and demonstration materials. To reinforce the commitment to advocacy and role modeling, all resources were developed by applying the same hardware and software that the students learn about in the course and which are prevalent in the schools.

For the educator with research and writing responsibilities, the development of publications provides a further opportunity to role model the use of both computer and communications technologies. This paper, for example, was produced using productivity software in conjunction with readily available screen image capturing utilities.

Audiovisual support materials can be effectively



	A	B	C	D	E	F	G	H
1	7	CHOOSING RANDOM NUMBERS						
2	5							
3	10							
4	8							
5								
6								
7								
8	NUMBER PICKED	UNIQUENESS TEST					DUPLICATION	
9	============	=====	=====	=====			============	
10	9	0	0	0			0	
11	4	0	0				0	
12	2	0					0	
13	7	0					0	
14	============	=====	=====	=====			============	
15							0	
16	NUMBERS ARE	9	4	2	7			
17								

=1+INT(10*RND())

=IF(A10=A11,1,0)

=IF(A10=A12,1,0)

0

=IF(G15=0,A13,0)

=MAX(B10:D10)

=SUM(G10:G13)

Figure 2
Choosing four natural numbers between one and ten

produced using computers. Figure 1 above is actually a template for a simple, yet fairly aesthetic, overhead transparency which was easily produced by using the potential of an inexpensive integrated software package as opposed to using more expensive and narrowly targeted presentation software.

Demonstrations/simulations. There are a myriad of ways in which the computer can be used in a demonstration mode - computer technology is very prominent in the delivery of both the IME and AME courses. One further example is presented here. In the area of mathematics, students are taught a variety of methods of finding the roots of equations ranging from factoring to synthetic division. Very often, however, equations do not have "nice roots" and thus defy algorithmically based solutions. In such instances, a simple spreadsheet, with or without plotting capability, can provide the teacher with a viable method of demonstrating how to estimate the roots of equations.

Using the graphics capability of the spreadsheet to plot the graph of the equation shows the roots clearly.

Problem solving. There are a multitude of ways to use the computer in problem solving situations both for teachers and for their students. The single example described here might be assigned to students who have prior knowledge of the use of spreadsheets. Specifically, the problem is to generate a spreadsheet which will automatically pick four natural numbers between one and ten. The problem can be solved with varying degrees of proficiency according to the extent to which the solutions address the question of repeated number selection. Figure 2 shows two potential solutions.

The simpler of the two solutions is in cells A1 to A4. All this solution does is to employ the spreadsheet's random number generator to pick a number between one and ten—the prospect of selecting repeated numbers is not dealt with at all. The more sophisticated solution (in the block of cells A8-G16) also does not avoid the selection of repeated numbers but it does check for their presence and will not print the selection in the dark-bordered box unless the four numbers are unique. Students may come up with one of many minor variations on the more sophisticated of the two solutions. The most sophisticated solution might employ the use of macros to ensure that the four numbers are not printed at all unless they are unique. The solution to the random number problem might be of interest to those whose retirement plans are rooted in winning lotteries. Regardless, the problem offers an interesting way for students to hone their problem solving skills.

Instructor uses of the computer for problem solving and instructional support abound but the development of spreadsheet alternatives which, among other things, automatically assign stanine grades without the use of logical "and/or" functions provides an interesting example.

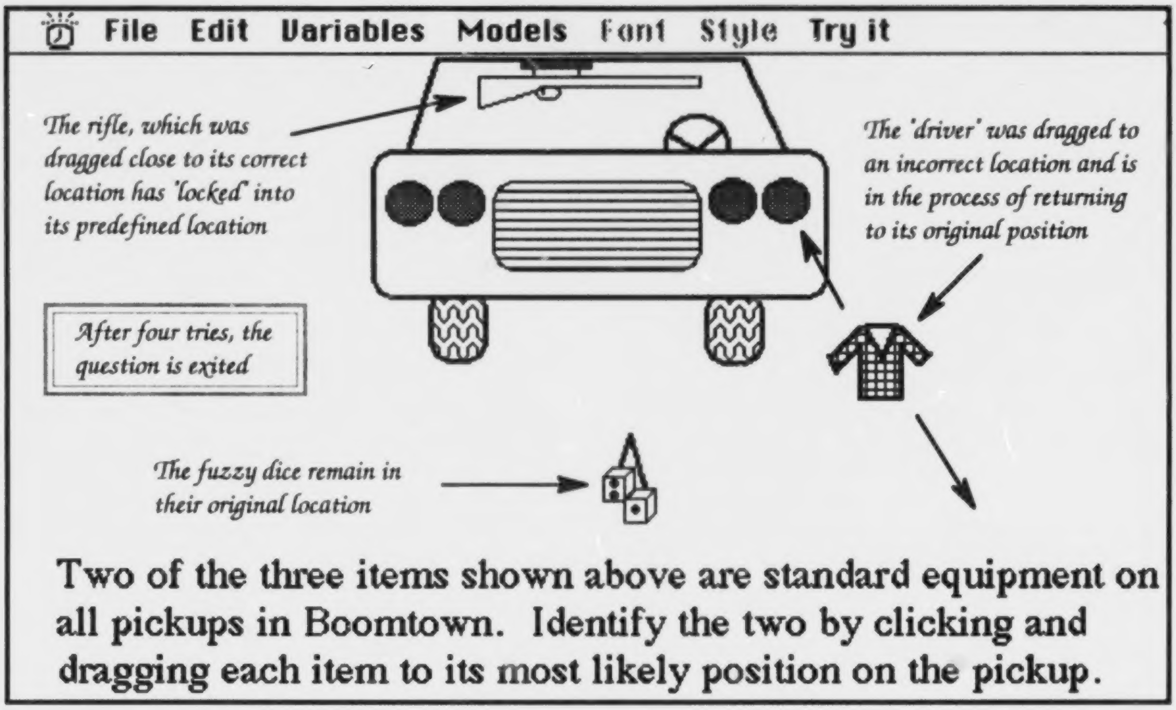
Communications. Information technology can be used by educators in a variety of ways for electronic communication with peers and colleagues. A more down-to-earth application, however, is for teachers to use computers to enhance the quality of communication with their students. Typically, such communication is non-electronic: for example, the merging of marks from a database into a customized reports to students. Students not only appreciate such communication but, importantly, are likely to acknowledge it as an appropriate use of the technology.

Instruction. Advocating and role modeling the use of computers for the delivery of instruction is relatively easy - many successful precedents exist. Aside from the many and diverse ways of using the computer as a tool, there are sophisticted authoring tools such as hypermedia and authoring systems - in addition to offering the capability to present information, these applications often offer interactive methods of evaluating student learning. It is not easy to demonstrate the power and potential of authoring tools in the print media; Figure 3, however, an extraction from a screen in an authoring system assignment in the AHE course depicts a "move and match" question which depends on the interactive potential afforded by computers.

Instructional support/Personal productivity. Many of the examples discussed under previous headings reflect the role modeling of computer use for instructional support/personal productivity. The use of spreadsheets to compute course final marks and to automatically convert these to stanine grades for a student enrollment of 140 requires little or no justification—suffice it to say that this use ensures that first semester courses can be completed before second semester courses begin.

Discussion

While the opportunities to advocate and role model the use of information technology in the computer literacy education of teachers abound, there are some who have expressed pessimism that this will occur soon - particularly in university programs. Gooler (1989), for example, has conjectured that very little role modeling in the use of technology goes on in the university and states that "as a general rule, teacher preparation classes tend to be taught quite free of instructional technologies, particularly the emerging information technology systems students may be urged to learn about." He observes that the curricular location of the technology training component says a lot about the institutions' perspectives on the area and goes



The rifle, which was dragged close to its correct location has 'locked' into its predefined location

The 'driver' was dragged to an incorrect location and is in the process of returning to its original position

After four tries, the question is exited

The fuzzy dice remain in their original location

Two of the three items shown above are standard equipment on all pickups in Boomtown. Identify the two by clicking and dragging each item to its most likely position on the pickup.

Figure 3
Example of an authoring system, move and match screen image

on to remark that in many cases "professors identified as instructional technologists in a school of education have little involvement in (and no discernible influence on) preservice teacher preparation programs." Hopefully this has changed.

The desirability of role modeling was recently reiterated by Kennedy (1991) who states that "teachers are highly likely to teach in the way they themselves were taught."

One very positive thing that has occurred over the course of time is that, in the universities at least, computer education is being offered at ever decreasing course levels. Two important points are implied by this, firstly, that computer knowledge is of wide ranging importance and secondly, that such knowledge should be acquired early in a student's program. Wright (1992) notes two obvious benefits of this trend for prospective teachers, notably that:

1) the earlier that a student learns about information technology, the sooner s/he can personally reap the benefits.
2) the greater the number of positive/beneficial interactions that the students have with computers, the more likely they are to both advocate and role model their effective application.

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Three case studies of preservice teachers perspectives toward computer technology

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Teacher education is once again at the forefront of the educational reform agenda (Goodlad, Soder, & Sirontnik, 1990). One current issue in teacher education deals with computer education for prospective teachers. A legion of technology educators (Dupagne & Krendl, 1992; Hannafin & Peck, 1988; Mehlinger, 1989; Moursund, 1989) as well as a host of national reports (National Task Force on Educational Technology, 1986; Office of Technology Assessment, 1988; Sununu, 1986) have called on schools of education to increase technology training during preservice teacher education. Presently 23 states and the District of Columbia require teachers to have at least some training in microcomputer use to become certified (Bruder, 1989). Many college programs of teacher education have developed courses in computer education in reaction to such reports and certification trends (Kull & Archambault, 1984). Critics of such courses charge that the typical educational computer course used to prepare classroom teachers fail to remember one of the central lessons of our previous experiences with technologies in education: that teachers in general did not learn enough about the machines to be able to integrate them into their classrooms (Wagschal, 1984; Komoski, 1987; Gayeski, 1989).

It is difficult to comprehend how anything can be improved significantly unless its present situation is thoroughly understood by those seeking change. To help gain such understanding, the following study investigated one current computer education effort by describing and interpreting the perspectives of three of the preservice teachers enrolled in it.

Design of the Study

The respondents whose perceptions formed the focus of the study were three elementary preservice teachers enrolled at a large research university located in the East. Intensity sampling (Patton, 1990) was used to select the respondents.

Qualitative case study methodology (Merriam, 1988) based on the naturalistic paradigm (Lincoln & Guba, 1985) was the mode of inquiry. Data was collected through participant observation (Spradley, 1980), during which the researcher attended each class with the respondents in the role of researcher participant (Gans, 1982), through semistructured (Borg & Gall, 1989) and ethnographic interviews (Spradley, 1979), and through analysis of course related documents and student made artifacts (Goetz & LeCompte, 1984). The researcher used the inductive data analysis procedure described by Lincoln and Guba (1985) to interpret the data.

Presentation and Interpretation of Case Data

The first respondent,Tess, described herself at the beginning of the study as computer novice who was "really computer illiterate" and "scared to death" about computers. She stated that she preferred to use her typewriter to complete required assignments. Her early perspective about the use of computer technology in education was that computers were being integrated more and more into the classroom. She felt she had an obligation as a fledging educator to learn about the technology so she could introduce it to her students in the "proper way." Tess had received very limited contact with computers or technology in general in her education to this point. This lack of technology knowledge made going to the computer lab an intimidating experience for her. Though fearful, she felt confident enough in her ability to learn, and set the goal of becoming a "computer wiz."

Though early class sessions proved initially nerve wracking and overwhelming for Tess, the researcher observed a pattern of growing self-confidence in the area of computer use. She was eventually able to use the computer lab by herself and complete an assignment. As classes progressed, the researcher noted that Tess slowly moved from a passive and uncertain receiver of information on computer use, to an active guide and helper to others in the class. These critical incidents had a great impact on her personal self-confidence as a computer user.

Though initially unwilling to give up the comfort of her friendly typewriter, Tess progressed during the study to the stage where she was using the computer exclusively to complete her college assignments, even though she did not have personal access to a computer other those in the college.

As the various applications were presented during the course, Tess continually returned to the theme of how she could use the applications to have fun with her future students. She consistently viewed each new application through a lens of creative action, and was more drawn to the programs that she felt either she or her future students could use in a fun and creative way. Tess viewed the computer as a tool that could be used to enhance her teaching ability and the learning potential of her students, but not as a replacement for the teacher.

The researcher also observed that the way the class was structured did not match Tess's preferred style for learning about the technology. The class generally offered whole group instruction with only occasional breaks for student questions and time to allow for students who had fallen behind to catch up. What Tess preferred was for someone to sit down with her individually and guide her through each step of an application. She did not want to misunderstand a step or fall behind in a procedure, because this led her to a feeling of frustration and intimidation.

Though not living up to all of her personal expectations, the course did alter Tess's perspective about computers. She no longer feared computers or the lab setting, and by the end of the course was actually using computers in that context as a personal tool. She viewed herself as someone who now had enough of a general understanding about computers and their various applications to feel some confidence about using them with her students in a future classroom. Though feeling more comfortable, she still harbored doubts about her proficiency with the technology. Her intent to purchase her own personal computer so that she will have unlimited access for practice and experimentation, as well as having access to someone to answer questions and offer suggestions, will be her solutions to this issue. It is the researcher's assertion that given access to the technology in her future school setting, as well as the availability of someone knowledgeable about computers to act as a guide or mentor, Tess will use computers with her students in ways that she feels are creative and fun and that enhance learning for both the student and the teacher.

Laura, the second respondent, described herself at the beginning of the study as an occasional computer user who was familiar with word processing, but felt that she actually knew very little about the technology. She confessed to having a "really big fear" of computers and wanted to take the course to "get rid of her phobia." She felt that there would probably be a computer in her future classroom and that the kids would probably know how to run it. She didn't want to "go in there and look stupid" in front of the children. She also acknowledged her perception that taking such a computer course as part of her teacher preparation would give her an advantage in a competitive job market.

The researcher observed and the respondent confirmed an initial pattern of boredom during the first several class sessions. These sessions dealt with topics the respondent was already familiar and confident with. She felt that these initial sessions went too slow for her, that she spent too much time waiting for others in the class to catch up, and that the early assignments were too easy to complete and thus unmotivating.

Throughout the course of the study, the researcher observed a pattern of Laura picking out and valuing what she perceived to be the practical examples of applications that might save her time as a future teacher. For example, being able to save documents for future use with maybe a slight alteration, such as a welcoming letter to parents that could be "recyclable" from year to year by simply changing the date, was a feature of computer use Laura found highly desirable. On the other hand, she did not want to "make a project out of everything that I do." For example, she did not want to spend "thousands of hours" trying to figure out how to use a graphics program to make a design or picture that might be easier to simply create by hand. As she commented during the last class session during a discussion on how the course had prepared the class to be teachers, computers will "make life easier—we can concentrate on lessons instead of figuring out grades."

The researcher also observed that the way the class assignments were structured did not match Laura's preferred style for learning more about the technology. Laura felt she would have learned more effectively from more in-depth assignments that made her rethink how to use the various applications in new or different ways, rather than assignments that she perceived just "regurgitated" what was done in class.

Though not living up to all of her personal expectations, the course did alter Laura's perspective about computers. She no longer felt "phobic" about them, perceived computers as now being her "friends", and felt that computers were more "conquerable" for her than she had originally envisioned. She admitted to feeling more "comfortable" with computers and less "nervous" about using the technology and also reported that she found herself going to the computer lab more often to meet her personal needs. However, she still shared doubts about her effectiveness to share her computer knowledge with her future students. She thought she would be more willing to try new programs with the children if she had "someone there to explain the program to me first and leave a guide book," or had a "computer wiz student" in the classroom to assist her. It is the researcher's perception that without such assistance in the future, Laura will probably continue to use computers as a personal tool, but may not feel proficient enough to use the technology with her students as an instructional tool.

Elizabeth, the third respondent, described herself as an experienced computer user who "had been living with computers ever since they came out." She reported that she had learned much about computers from her father, who she described as a computer wiz. She felt very confident and positive about using the computer, and viewed the computer course as just another graduation requirement that needed to be met.

When Elizabeth did attend class sessions to observe and follow the instructor in the application of a piece of software, the researcher observed a pattern of frustration and boredom. Elizabeth was very quick to pick up on whatever the instructor was demonstrating, and often intuitively jumped several steps ahead in a program before being given specific instructions to do so. The researcher noted that she was continually waiting for the rest of the class up to catch up. She also was disappointed that the course did not live up to her preconceptions as an independent study for those who had their own computers, and that the software needed to complete the course was only available for use through the university computer labs. Instead, Elizabeth wanted to use her personal computer so she could go at her own pace, which she perceived as "quite faster" than the pace in the class setting, and preferred instead to "play with the programs and figure them out" on her own.

Another theme that emerged from the data was Elizabeth's negative view of the future usefulness of many of the software applications that were introduced during the course. Though she perceived herself as "definitely" using and "living with" a word processor to store lesson plans and make up tests, and "possibly" using a spreadsheet to keep student grades, she viewed other uses and applications as "a lot of work" or "too much trouble." Elizabeth was looking for ways for the computer to save her time and energy in her future teaching career, and clearly wasn't interested in applications that she perceived would complicate simple tasks. As she concluded, she was "just not very motivated to use all kinds of computer programs."

Though not motivating her to use various computer programs, Elizabeth did feel that the course altered her perspective about computers in education. She felt that what she learned in the course added to and strengthened her initial confidence with the technology. She also reported that she now saw more of a need for computers in the classroom, and for teachers to be educated as to how to use the technology. She had come to the understanding that "some people don't know about computers at all" a concept which she initially found "hard to believe." Instead of having a "whatever" attitude, she now strongly felt that future teachers should "be educated in computer use."

It is the researcher's perception that Elizabeth will continue to use her computer as a personal tool in the future but in a limited way, most probably for only the word processing application. Using the technology with students in her classroom will depend upon whether she finds the use easy to accomplish or as an actual time or energy saver when compared to more traditional means of instruction.

Implications and Recommendations

The perceptions of the respondents in this study seem to support the notion that present course offerings in computer use for educators present too narrow a technical focus and do not question "the broader educational value and significance of computers" (Callister & Burbules, 1990, p.4). The themes and patterns that emerged from the study are also consistent with the U. S. Office of Technology Assessment (1988) report that stated that when those now teaching or planning to teach receive computer training, much of the time is focused on learning about computers and not learning how to teach with computers. The report concluded that such programs are a beginning, but not enough to prepare teachers to use computers in a wide range of classroom applications. The findings from the current study suggest the same.

The findings are also congruent with the literature that suggests that individuals must pass through a variety of levels or stages of use before adopting an innovation. Hall, Loucks, Rutherford, and Newlove (1975) identified seven such levels of use. The data from the current case studies suggest that at the end of the study all three respondents were at Level III-Mechanical Use. The user of the innovation at this level is described as being in a state where the user focuses most of his or her efforts on the short-term, day-to-day use of the innovation with little time for reflection. They are looking for uses more to meet the user's needs than the needs of students or others. The user is further described as primarily engaged in an attempt to master tasks required to use the innovation, with these attempts often resulting in disjointed and superficial use.

Reiber and Welliver (1989) have also identified five levels of technological usage that the computer user must pass through. These stages are familiarization, utilization, integration, reorientation, and evolution. The themes that emerged from the present case study suggests that the respondents have passed from the familiarization stage into the beginnings of the utilization stage, though they still harbor some doubts about the benefits of the technology. The findings also imply that more contact with computers in a variety of experiences must occur if preservice teachers are to pass on to the desired higher levels of technology use.

The implications presented suggest that teacher educators must revise their current technology training programs if preservice teachers are to successfully use computers with their future students. Following are some recommendations for practice. It should be noted that these recommendations should be used together as part of an interrelated and comprehensive approach to technology education. First, preservice teachers, especially those with little or no prior computer experience, need to complete a general computer literacy course in the first year of their college preparation. This would allow the presevice teacher to practice and experiment with the computer as a personal learning tool throughout the remainder of their college experience. Closely related to this recommendation is the call for all preservice teachers to have unlimited access to a personal computer during their teacher training. This could be accomplished by teacher education programs requiring their majors to purchase an inexpensive personal computer as a condition of enrollment, as many schools of engineering currently do, or by the respective college of education offering a loaner program to its preservice teachers for a minimal fee.

A third recommendation is that college faculty in all disciplines, not just education, should model the appropriate use of computers throughout the college curriculum, including the assignment of computer related activities. For this to take place, a related recommendation would be that college faculty who are not currently computer literate be provided the training and resources necessary to make them so.

Since numerous studies suggest that the field setting and cooperating teacher have a direct influence on the selected practices of preservice teachers (Cruickshank & Armaline, 1986; Zeichner, 1986), it is also recommended that preservice teachers be placed in field settings where educational technology is used and encouraged.

A final recommendation is that teacher educators review the literature from staff development research, especially the findings of Joyce and Showers (1988) in regard to teacher training, when designing computers for educators courses. These researchers have determined that training should include the exploration of theory, demonstration or modelling of a skill, practice of a skill under simulated conditions, feedback about the performance, and discussion. They also note that peer observation and coaching is critical after training in order for the transfer of more complex teaching skills to occur. Sparks (1983) also emphasizes the importance of small-group discussion and problem solving during training in order to aid learning and promote transfer to the classroom. The current course offerings might be improved if the students received more practice with the various applications and also received more detailed feedback about their performance through peer observation and coaching. Small-group discussion about the broader educational and social implications of computer use in education would also promote transfer. As Apple (1991) recently suggested, such discussions would be the ideal time to question whether the wagon we have been asked to ride on is going in the right direction.

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Teacher education: Retooling with technology

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Educational Technology Initiative

The Utah Educational Technology Initiative (ETI) is an attempt to increase the learning of math, reading, language arts, and other subjects in the public schools with technology. ETI provides over 45 million dollars for hardware purchases. Utah has taken an aggressive stance to overcome the problem of little or no technological impact in schools as mentioned by Elmer-Dewight in Time magazine 1991 "...the impact of all this technology on the basic operation of most classrooms is practically nil" (p. 48). Clearly, higher education, particularly departments of teacher education, has a direct responsibility to develop teachers who can and do use technology effectively. The development of technological expertise is cogent for both preservice and inservice teachers. Weber State University's (WSU) Teacher Education department is responding to ETI in four ways:

1. Establishing an education technology center.
2. Training teacher education department faculty.
3. Developing inservice classes for public school teachers.
4. Revising the teacher education program.

Educational Technology Center

In addition to every faculty having a networked computer in their office we have developed an Educational Technology Center (ETC) that is located in the Teacher Education Department and is readily accessible to faculty. It houses multimedia units for LCD projection, CD-ROM, Laserdisc, scanning, and video digitizing. A small network of machines in both MS-DOS and Macintosh platforms is available. Currently five of the units are mobile. Each Station is equipped with a LDC panel, overhead, CD drive, and speakers for classroom use. Faculty members are encouraged to schedule the ETC for classes or to move the units into their own classrooms.

Training Faculty

No training started until all the equipment was in place and functional. This allowed faculty to work on the actual machines that were available for them as they were trained. Training consisted of three day workshops covering basic hardware and software use in multimedia presentations. Hypercard was used to present text and control peripherals such as CD drives and laserdisc players. Scanners and video digitizing equipment was also available. Faculty were to attend the workshops and produce a project based on the skills acquired in workshop that could be used in their personel instruction. After the workshops had been completed, instructors were available through the remainder of the quarter to help the participants complete their projects.

Inservice Training

A similar format was used for the inservice training. Districts were first contacted and given a list of possible training topics. Districts then approached their teachers and had them identify the topics of interest or list other needs. These topics formed the basis of the workshops. Credit was provided by the University through continuing education for a small fee. Districts then advertised and selected teachers to attend.

Training teachers to use technology does make a difference. Ryan (1991) has reported that teachers trained with a minimum of 10 hours of instruction in technology were able to achieve greater academic gains with their students.

Our training focused on awareness of current technology (hardware & software), its function, and its purpose. Ideas were developed and shared on the effective integration of technology into instruction. Basic elements of hardware, software, and presentation techniques were often unfamiliar to teachers. Knowledge of these elements can help teachers make informed choices about technology and teaching. These workshops were held both on campus and in schools to acquaint teachers with the broadest range of technology available and to show them what was currently available in the districts to work for their use.

Revision of Teacher Education Program

In the Teacher Education Department three major changes are taking place. The first is a proposed increase of the admission requirements. Students must be computer literate to be admitted into the teacher education program. This means that they must have a working knowledge of word processing, spreadsheet, and database applications. Most recent graduates of high school are able to show competency in word processing but are unfamiliar with database and spreadsheet use. Returning students may have some general computer experience but it is seldom complete.

Second is the changing of two courses dealing with technology, Instructional Media and Educational Computing, from low tech, introductory courses to high tech, multimedia formats stressing the use of technology (e.g., video, CD-ROM, laserdisc, hypercard). The first course, Instructional Media focuses on introducing students to the concepts necessary to use various media in an effective manner. Students learn how to develop presentations for use in teaching and how to use appropriate technology for presentation. The second course, Educational Computing, extends these concepts to develop instructional materials to be used with whole class presentations or small group instruction. The overall objective is to provide a basic understanding of how technology can aid the teacher in teaching and the student in learning. Teachers need to view technology as a tool (Taylor, 1980) that will allow them to do regular tasks better, also to do things that were not possible without the use of technology.

Third is the modeling of technology use in courses within the Teacher Education department. Various instructors are incorporating technology, including multimedia presentations into their courses. Courses in the areas of secondary teaching methods, elementary social studies, elementary reading, secondary measurement and assessment, special education, and math are modeling technology integration for students. Students are watching demonstrations of technology use to enhance their own learning and becoming accustom to its inclusion in the teaching learning process. They are aware of the effort that is required to utilize technology for teaching but are also experiencing the benefits of the technology.

After teachers become aware of what technology is available for use, they need to consider how to incorporate technology into content learning. In this area technology is not a teaching tool as much as a tutor to present concepts, facts, etc., to students. Software becomes a prime focus to convey information and knowledge to students. Examples are Hypercard stacks, CD-ROM, Laserdiscs, and other programs that present material for learning. As students become familiar with these programs it is possible to put them in charge of their own learning by fostering the development of individual materials and presentations. Students can then pursue their own avenues of interest and provide information to peers through the use of technology.

Summary

The philosophy that undergirds our effort is that the schools are the primary unit of change in the educational system. By training inservice teachers and preservice teachers to use technology in their classes change will occur. To facilitate this we believe that a collaborative environment is necessary in teacher education. We as teacher educators need the input of district personnel along with inservice teachers to gain the perspective necessary for educational improvement. Technology is very important for both students and teachers. It has the potential to make a positive impact on the way a teacher teaches. All teachers deserve equal access to technology. All students deserve equal access to learning and technology. Training inservice and preservice teachers to use technology will help make these goals a reality.

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Learning technology: Implications for practice

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Introduction

The introduction of the personal computer a little over a decade ago prompted a flurry of interest in computer technology. The "computer literacy crisis" was born and computer classes became increasingly more common in public and post-secondary educational institutions (Collis and Martinez, 1989; Lowe, 1991).

Computers in education courses are often adult computer literacy courses and are typically competency-based skills courses. Often teachers learn to use the computer in isolation from classroom practice, and outside the teachers' own existential learning experiences. Many teachers begin their careers and continue their professional practices having thought very little about how their own learning experiences impact their teaching practice (Butt and Yamagishi, 1988; Zeichner and Liston, 1987).

As collaborative instructors in delivering a senior level Computers in Education course, we used our backgrounds in computer technology, educational psychology, instructional design, and style differentiated instruction to design a course that would allow students to grow as learners of technology and, at the same time reflect on how those experiences would impact their teaching practice. Based on the belief that teachers powerfully shape the learning experiences of their students by creating environments which demonstrate proclivities towards particular learning styles that teachers themselves hold (Butler, 1986), we used reflection on learning as the primary vehicle to reveal to teachers how their attitudes and actions, however subtle, create learning environments for their students by establishing acceptable learning procedures, processes and products within the classroom.

This paper shares the teachers' experiences and reflections about their learning and teaching with technology through their reflective journal entries and through instructor observations of that growth process. It discusses the relationship that exists between teachers' learning preferences and teaching practices, a relationship significant for instructors of technology at all levels of education.

Method

This qualitative study was conducted over a three-year period and involved sixty teachers and student teachers across four sections of a thirteen week course. The student teachers were second year education students who had at least six weeks practicum experience. The teaching experience of the practicing teachers varied between two and twenty years. Few of the participants had experienced teaching a computer class. For purposes of convenience during the following discussion, teachers refers to both student teachers and practicing teachers.

While there exists a plethora of instruments and inventories to identify personality types, learner characteristics and preferences (Myers, 1962; Butler, 1986; Dunn & Dunn, 1975; Gregorc, 1982; Kolb, 1976), the teachers in this study were administered the Adult Style Delineator (Gregorc, 1982) at the beginning of the course to identify learning preferences. We then extended those identifications to the realm of the classroom through Butler's (1986) work in Style Differentiated Instruction, which focuses on curriculum development as a result of informed knowledge of teaching and learning preferences. There has been critical evaluation of Gregorc's instrument (Sewall, 1986); however, the strength of Gregorc and Butler's contributions lie in their applicability to classroom practice.

The Style Delineator was used as a fundamental organizer to discuss learning and teaching preferences. The instrument is based on dualities of ordering (sequentially or randomly) and perceiving information (abstractly or concretely). Four styles or categories of learning preferences or mediation ability channels are identified: concrete sequential (CS), abstract sequential (AS), abstract random (AR) and concrete random (CR). Although there is usually dominance in one category, individuals exhibit characteristics in all four categories. Table 1 illustrates the extension of learning characteristics and preferences to teaching characteristics and preferences (Butler, 1986).

The course was designed to achieve a balance between structured and unstructured, prescribed and self-directed assignments. In this way learners would experience learning environments which accommodated and challenged their learning preferences. The computer experiences and assignments were equally distributed and weighted between database, spreadsheet, word processing

Table 1
Learning and Teaching Preferences According to Style

Style	Learning Preference	Teaching Preference
Concrete Sequential	Tend to be practical, organized, thorough and structured. Prefer to create real, practical products and learn best in orderly quiet environments that have logical, consistent directions.	May create a practical, realistic, predictable learning environment. Structure and logic are fundamental to this view of teaching. CS teachers foster creativity through prototypes.
Abstract Sequential	Tend to be conceptual, convergent, analytical and evaluative. Prefer independent work, and may find creative, cooperative activities stressful. May be reluctant to relinquish authority and control to students.	Apply logic and sequential reasoning to abstract ideas in encouraging students to be analytical and evaluative. Stress a broad knowledge base supported with logical data.
Abstract Random	Tend to be emotionally intuitive, interpretive, empathetic, imaginative and flexible. Enjoy creative and artistic activities. Prefer collaborative work and give meaning to ideas in a personal way.	Respond in a personal way to students, environment and curriculum. Instill student self-confidence, and encourages self-expression. Encourage learning in a cooperative, sharing environment.
Concrete Random	Characterized as being original, experimental, inventive, option-oriented and divergent risk-takers. Prefer independent experimentation. Authority and limited options may pose problems for these learners.	Emphasize practical, realistic work expressed in original, creative ways. Enthusiastic, flexible and spontaneous teachers who prize diverse ways of learning and experimentation. Encourage creative problem solving and inventing useful, original products.

and programming. The application packages were introduced in the first half of the course and taught using lecture, demonstration, and walk-through formats. The programming language, LOGO, was introduced after the teachers gained some familiarity with the computer. We chose LOGO in order to provide an exploratory environment for creative expression, self-directed and self-paced learning. It was presented in a very unstructured manner introducing a minimum number of primitives through demonstration. From this point, teachers were asked to experiment, explore, read the manual, collaborate, and otherwise figure it out for themselves.

Throughout the computer experiences, the teachers were asked to maintain journals describing their learning experiences. Following the computer experiences teachers were given the results of their Style Delineator and asked to compare those results with what their journal entries revealed about their learning preferences. Teachers were then asked to share how an awareness and understanding of their learning preferences would impact their teaching practice.

Results

Teachers were surprised to discover how closely the results of the Delineator matched the learning processes described in their reflective journals. The following outlines the instructors' observations of the teachers' behaviors and includes selections from teachers' journals to illustrate the correlation between self-reflection and style type, as well as teachers' predictions of and intentions for how this information would influence their teaching practice.

Concrete Sequential

CS teachers requested clear concise directions during all phases of the course. They found the walk-through format especially helpful. Their assignments and projects demonstrated linear thinking and structured organization. Typically, CS teachers confined the use of the computer programs to classroom applications such as the development of electronic report cards, construction of classroom inventory databases, and generation of form letters to parents.

Initially, CS teachers found the LOGO programming assignment very frustrating. They had difficulty deciding what to do and never felt their project was really finished. Many resisted the project as long as possible and incorporated only minimal elements to satisfy course requirements. Play was not part of the CS agenda. As CS participants wrote:

> *During the first part of the course, I was given the opportunity to create something real and practical and that was very important to me.*
>
> *I really wanted just to follow directions and get correct answers and in the LOGO project there were no correct answers.*

Reflecting on their teaching style, CS teachers recognized the creative potential in their colleagues, often expressing admiration and envy of others' work. Although CS's found the unstructured and exploratory environment difficult, they realized a need to be tolerant of others' styles. Many said it would be essential to accommodate others' styles in the classroom. CS teachers did not readily extend the use of application programs beyond their utility as a management tool for the teacher, for instance, using a spreadsheet to teach math or a database to illustrate concepts in science or social studies. Most said they would use LOGO, because it allowed students to demonstrate their creativity. Other CS's admitted their reluctance to try it or use it with their students. They doubted the validity of LOGO as a useful teaching tool.

> *LOGO revealed something to me as a teacher. I will probably tend to be a director rather than a facilitator of knowledge. I am still not convinced that this is the best thing to spend classroom time on.I would find a project like LOGO hard to evaluate.*

Abstract Sequential

AS teachers followed the walk-throughs exactly and offered good suggestions for making them clearer. They were often concerned about the choice of software, questioning quality, appropriateness, and district or system authorization. They continually probed the merit of using any of the computer programs in the classroom. Many preferred to use LOGO for intellectual activities rather than produce physical products. Several AS teachers reported looking for more information about LOGO. Play did not appeal to AS teachers.

> *I've seen other word processors. It seems to me that we should be trying a couple of others.*
>
> *I would have like more time to read and discuss Papert. He has some interesting ideas.*
>
> *I didn't like playing with the turtle with no purpose in mind.*

In reflecting on their teaching, AS instructers said they would teach students to use spreadsheets and database applications. They saw value in exploring LOGO with their own students. They reported that they would be encouraged to provide their students with this kind of option in other curricula besides computer literacy classes. Several AS teachers mentioned wanting to instill question-asking in their students. Several also remarked how important the LOGO experience was in encouraging them to foster and allow for creativity in their own students.

> *I have some real reservations about allowing students to use spelling checkers.*

LOGO forces kids to think in different ways. I think that is good.
Even though I found LOGO difficult, I feel it should at least be explored in the classroom because of its educational value.

Abstract Random

AR's were particularly appreciative of the walk-throughs, many suggesting they would be "lost" with out them. They sought constant feedback and approval from both instructor and peers. AR's gained an appreciation for the importance of planning. They also recognized that other teachers seemed to be able to do it as a matter of course, and did not always learn as they did. AR's tended to personalize their computer experiences. They found working independently quite difficult and frustrating. However, many reported that having to learn to deal with their frustration was a difficult, but useful exercise. Making mistakes and play were not only acceptable, but encouraged—something that AR's had found wanting in many of their past educational experiences.

I knew I could be creative, but didn't get much chance in school until now.
I could have really used this when I was learning geometry. I haven't really understood it until now.
I liked how LOGO allowed me to make mistakes without being wrong or right.
I had to break complex problems into small pieces. I don't usually work that way.

Commenting on their teaching, AR's felt that creativity and adventure were important elements to include in learning experiences. They would encourage learning through mistake-making. They would also encourage collaboration among their students to facilitate discussion and group problem solving. They found planning a challenging, but rewarding activity, one from which they would want their students to benefit. Having identified with their own level of frustration, some AR's were concerned that LOGO might be too demanding and frustrating for students. Evaluation of student projects was already a worry for these AR teachers. How could they grade one student's assignment better than another's when each came out of the student's own minds?

I realize that I will probably let students do their own thing. I guess I've never seen myself as a teller, but more as a helper.

Concrete Random

CR teachers used the walk-throughs, but were often experimental and creative. For example, one CR teacher used the spreadsheet to correlate shoe size with the success of football kicks. They found the programming project particularly appealing and challenging. Self-paced, independent experimentation allowed CR's to maintain control of their own programs. Many regarded the assignment as fun and spent extra hours at the computer.

There are a thousand uses for these programs .
The fact that I could explore on my own was really important. I am a very independent learner. I like to be left to experiment and discover on my own.

In reflecting on their teaching, CR teachers felt that presenting learning in a discovery, experimental approach was what their students needed most. They were keen to use the application programs with their students and to extend the application programs across the curriculum. They viewed themselves as facilitators, regarding self-control, self-discovery and self-correction the most beneficial learning experiences to offer their students. CR's felt it important to transfer the idea that to play is to learn. Because the way these teachers experienced LOGO was contradictory to the way much curriculum had been presented to them as learners, they would make a concerted effort to include as much of this type of learning in other curricula as possible.

I would want my students to experiment through an investigative approach, to ask why, and learn about problem solving through active involvement.
I believe that LOGO is a great teaching tool. I want the children to explore and experiment with learning. I want them to think of ideas on their own. I want to be their guide, not their teacher.
I feel that children learn, understand and internalize information easier if they discover it for themselves in a hands-on situation. Learning has to be interesting, creative, and most important, fun!

Summary

Many of the findings in this study were predictable. Almost all teachers, regardless of style type, appreciated the walk-through format for the assignments. Walk-throughs allowed the teachers to concentrate on application rather than technique. It also gave them the opportunity to either work in a group or independently.

It was through the programming assignment that style preference became most noticeable. Teachers were able to individualize their projects and make personal statements about what they learned and what they considered important in facilitating their own learning. In the initial stages, almost all teachers experienced some frustration. The opportunity to explore and create with minimal direction was a new approach for many.

Teachers with sequential learning styles found the LOGO assignment particularly challenging. They produced the most geometric designs that employed comparatively little imagination. Although they could relate LOGO to students, they admitted being uncomfortable with using it themselves and were skeptical of using

LOGO with their own students in the classroom. These teachers were most reflective about recognizing that other teachers learned differently than they did. They realized that it would be necessary, in fact vital, to develop curriculua in other than sequential, structured ways for students.

Random style teachers enjoyed using LOGO more than sequential style teachers. They conquered their frustration quickly and soon regarded the assignment as challenging and fun. Many were surprised at their own creativity. Grateful for the experience, they wished they had encountered LOGO earlier in their school careers. They were particularly positive about using it with their own students and looked forward to the opportunity to teach LOGO in their own classrooms. For some of these teachers, it was a revelation to find that LOGO, as presented, fit so well with how they discovered they learned best. It is not surprising that these teachers produced the most imaginative and interesting projects, a fact with which even the sequential styled teachers agreed.

All teachers became aware of and gained an appreciation for the diverse learning needs of others. While CS and AR teachers reported the greatest desire to adapt curriculum to suit a variety of learners, it is significant to note that the CR teachers, who found the LOGO experience most closely matched their learning preferences, were the most adamant that LOGO be taught in the way they had experienced it. These teachers reflected very little on the difficulty that more sequential teachers experienced in this self-directed, exploratory environment. The most flexible, creative learners were the least flexible in accommodating others' preferred learning styles.

Implications for Practice

That they will probably teach and present curriculum in accordance with how they learn, is a significant lesson for teachers, a lesson that should come early in a teacher's education. Providing teachers with the opportunity to participate in or observe problem solving processes different from their own, and for some, different from what they had ever experienced, is a valuable learning process for teachers. Not only do they gain a heightened awareness of their own learning preferences, but an appreciation for others' preferences. Awareness is the first step in transferring this appreciation into classroom practice.

Encouraging creative thought and independent learning are important and admirable objectives. However, it is equally important for teachers to adapt curriculum to suit a variety of learners. Teachers with flexible, creative learning preferences must also be flexible and creative in accommodating learning styles not suited to little structure or guidance. "Flexing," as a means to appreciate others' gifts is the ability to recognize and provide for particular learning or teaching preferences outside one's own dominant style (Butler, 1986).

In content areas such as technology, which is generally highly structured and inflexible, it is doubly important to promote a reflective stance towards how teachers will teach technology. Recognizing that not all students will benefit from the curriculum in the same way, poses issues as to what curricular options are offered to students in relation to what kinds of assignments they are required to produce.

Spreadsheet, database, word processing and some form of programming assignments are fairly generic across introductory computers in education courses. However, programming has been overshadowed by the practical importance of learning computer application programs. Programming, especially when using LOGO as a discovery environment, allows for a diverse range of styles to manifest themselves, not only to the teachers, but to the instructors of teachers. The programming assignment becomes a mirror for the teachers to recognize their own style strengths and weaknesses. They are able to reflect on that information and use it as insight into how they would teach computer literacy and more significantly, how they would deliver and design curricula in general. As an observational tool for instructors and a platform for teachers to examine their own learning, the LOGO environment provides the springboard for mindful consideration and reflection of learning and teaching preferences that impact teaching practice.

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Cultural sensitivity in classroom computing

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Minority students are rapidly becoming the majority in American classrooms. In fact, the American Association of Colleges for Teacher Education (1990) predicts that the minority school-age population will increase more than 30 percent within the decade. At the same time, the ratio of students to computers is decreasing as more computers enter the schools (Hayes, 1992). In view of the concurrent increase in educational computers and the growth of minority student populations, teachers must implement instructional practices that provide all students with equitable access to technology and maximum opportunities for academic success.

Educational equity implies providing for those differences which moderate learning and achievement. One of the most important differences affecting learning is culture. Culture shapes thinking, perception, expectations, values, beliefs, and behavior, as well as how we view the world, what we consider important, what we attend to, how we learn and how we interpret information (Philips, 1983; Delagado-Gaitan and Trueba, 1985; Huitt, 1988; Jacobs and Jacobs, 1988; Jacobs, 1990; Rhodes, 1990). Although individual differences exist within cultural groups, research indicates that cultural differences in cognitive and learning style preferences exist across cultural groups (Ramírez and Castañeda, 1974; Tamaoka, 1986; Vogt, Jordan and Tharp, 1987; Singh, 1988; Griggs and Dunn, 1989; More, 1989; Jacobs, 1990; Rhodes, 1990).

From a cultural constructivist standpoint, educators must acknowledge that computer-mediated activities stimulate qualitative interactions and instigate social arrangements (Scott, Cole and Engel, 1992). Classroom computers engender changes in individual roles, procedures, communication, and behavior. How teachers plan for, organize and use computers with their students alters the classroom culture, changes students'and teachers'roles, determines computer access, and directs students'learning (Cochran-Smith, Paris, and Kahn, 1991; Cohen, 1988/89; Hungwe, 1989; Mehan, 1989; Sheingold, Kane, and Endreweit, 1983). Given the pedagogical importance of cultural differences, the use of classroom computers with culturally diverse populations requires a careful examination of the technology, its use within the classroom and its effect on students.

The Culture Computer and Equity

Hoopes and Pusch (in Pusch, 1979, p. 3) state that culture includes "values, beliefs, esthetic standards, linguistic expressions, patterns of thinking, behavioral norms, and styles of communication". From this perspective, the cultural collage within the computer-using classroom created by the diversity of individual backgrounds and the shared classroom culture, also incorporates a computer culture. Computers are not culturally neutral for they embody the cultural perspective of programmers, manufacturers, and software developers (Bowers, 1988; Scott, Cole and Engel, 1992). In using the computer, the user engages in an indirect communication with the programmer. Both the user and the programmer bring to the communicative process their cultural assumptions and epistemological perspectives. As Bowers (1988) contends, computers promote analytical, linear thinking and exalt individual autonomy. Furthermore, the computer culture discerns logic "as a powerful instrument of thought"and favors top-down, rule-driven, decontextualized activities (Turkle and Papert, 1990; Bowers, 1988). In short, the computer culture discriminates against concrete, global, inductive, field-dependent thinkers.

Educational equity in classroom computing provides for cultural preferences in cognitive styles; recognizes cultural differences in learning styles; equalizes access to hardware; and distributes quality, challenging software fairly. Not all cultures value abstract, analytic, linear thinking. Some minority groups prefer global, concrete, and nonlinear thinking. Many individuals, particularly women, prefer to interact with a new object, "learning about it through its behavior"and to progressively negotiate their work rather than follow a predetermined hierarchical plan (Turkel & Papert, 1990). Forcing these holistic, concrete thinkers into a cognitive mode that is quite different from their preferred way of thinking places them at a clear disadvantage. Similarly, many cultures shun individual autonomy, impersonality, and competition and favor mutual interdependence, familiarity, informality, and cooperation. On the other hand, the classroom computer culture advocates individual autonomy, as evidenced by the terms *student-initiated* and *individualized courseware* (Bowers, 1988). The gap between cultural and individual preferences and the computer culture creates alienation as individuals struggle to become what they are not (Turkel & Papert, 1990).

Equity in computer access is another important issue. Most children in economically impoverished schools, many with bilingual and English as a second language (ESL) programs, have limited access to computers and to computer applications (Johnson, 1985; Arias, 1990; Cohen, 1988/89; Dunkel, 1990; Gifford, 1991). Children with limited English proficiency are usually submitted to drill and practice or tutorial software requiring low level cognitive skills (Cohen, 1988/89; Johnson, 1987; Cummins and Sayers, 1990). Although drill and tutorial have their place, they should not be the only computer experiences provided the non-native English speaker. The scarcity of computer proficient Bilingual, ESL and Multicultural teachers exacerbates the problem of computer access (Gifford, 1991). Clearly, "the success of technology in education depends on the teacher's competence in using existing methods and adapting to future developments" (Bitter and Yóhe, 1989, p. 22). When teachers are neither comfortable with, nor knowledgeable about computers, the classroom computer becomes a useless artifact surrounded by an invisible barrier of apprehension, confusion, and even aversion.

Teacher Preparation for Educational Equity

To ensure cultural and technological competency among teachers and educational equity in educational computing, teacher educators must first acknowledge the increase of culturally diverse classrooms, the diffusion of computers in American schools, and the role of culture in learning and classroom interaction. Having contemplated these realities, the next step is to develop preservice activities that prepare culturally and technologically competent teachers for multicultural and minority classrooms.

The preparation of technologically competent teachers entails hands-on experiences with a variety of hardware and software and direct observation of their classroom applications. Preservice teachers need knowledge of basic computer terminology, proficiency in using computer hardware, insight into the pedagogical potential of technology, awareness of conceivable disadvantages, and a readiness to use technology for personal, professional and instructional applications. Teacher training experiences in software evaluation must develop awareness, not only of program quality, program types, and ease of use, but also of cultural suitability, cognitive load, affective variables, instructional adaptability, and learning style flexibility. During student teaching, preservice teachers should demonstrate an ability to integrate traditional methods, culturally appropriate strategies, and educational technologies in multicultural classrooms with minority students.

Despite the growing diversity in the American classroom, teacher educators continue to pretend "that their graduates will teach in schools with white, highly motivated, achievement-oriented, suburban, middle-class students from two parent families"(Irvine, 1990). With the growth of minority populations, most teachers will serve in linguistically and culturally diverse classrooms. Therefore, all teachers—elementary and secondary, mainstream, Bilingual or ESL—should be culturally competent and know how to teach content to children whose native language is not English. In evaluating software, teachers should be able to assess the level of language difficulty and to implement strategies that will help students overcome the language barrier. For example, cooperative learning techniques where students are paired at the computer not only helps limited English proficient students develop oral language skills, but it also helps them access more linguistically demanding software than when working alone.

Equally important is an understanding of how the cultural background affects the child's tolerance for noise, public criticism, personal rewards, and supervision. A computer placed in a highly visible area of the classroom may discourage some cultural groups which value privacy and not "losing face."Similarly, a program that indicates an incorrect response or error with an audible sound or large on-screen message readily seen by other students is inappropriate for these students. Other cultural differences that may hinder some students are the graphics displayed and the program content. Graphics presenting culturally alien objects or animation showing culturally unacceptable behavior should be avoided, or at best, supplemented. For example, Discis Books by Discis Knowledge Research Inc., an interactive CD series of bilingual books, have a very effective pedagogical basis. They provide bilingual Spanish students with visual clues, auditory explanation in their native language, as well as English auditory and visual input. However, most of the stories have culturally biased graphics that show white children and adults and no ethnic diversity. This software would be much more potent if stories showed ethnic diversity in its characters, included stories from the children's native culture, or provided topics related to the children's cultural background. Likewise, content may be culturally unfamiliar, offensive, or biased. Teachers need to carefully examine software content and graphics for stereotypes, invisibility of groups, under representation of groups, gender bias, linguistic difficulty, and cognitive demand.

Conclusion

Preservice teacher preparation cannot ignore the realities of an increasingly diverse population and the growing use of computers in American classrooms. With these phenomena comes a responsibility to prepare culturally and technologically competent teachers capable of employing varied teaching strategies, selecting and adapting instructional materials, and providing cognitively challenging content and activities for culturally diverse student populations. Teacher preparation must provide a variety of experiences with a diversity of cultural groups and with a range of educational technologies. Direct experiences with cultural diversity and technology will reduce both technophobia and xenophobia which are products of ignorance and unfamiliarity.

Finally, educators must clearly understand the impact of cultural differences on the technology in the classroom. Researchers need to investigate the relationship between culture and technology and to answer some relevant questions. What specific cultural differences negatively affect students'use of educational technology and learning? How can students'cultural preferences in cognitive and learning styles be incorporated in the use of technology? Which characteristics of technology, (e.g., sound, visuals, abstractions, concretization, animation) are most educationally beneficial for specific cultural groups? Are these characteristics equally beneficial across cultural groups? How do successful teachers of minority students organize and manage their classrooms to maximize the benefits of educational technology for their students? The answer to these questions will help identify cultural adaptations in classroom organization, software adoption, and teaching strategies that encourage productive use of technology among students from a diversity of backgrounds. Without a better understanding of the interrelationship between culture and technology, teacher education in these areas will remain generally ignored, or, at best, merely hypothetical.

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Access technology for special populations: Not just "special" education

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Access Technology for Special Populations

The population of learners attending public schools has changed drastically over the past twenty years since the implementation of Public Law (P.L.) 94-142, now known as the Individuals with Disabilities Act (IDEA). A very diverse group of youngsters representing many disability groups is now mainstreamed into regular education classrooms. This has increased the need for the classroom teacher to understand the impact of disabilities on overall development and approaches to learning.

The Regular Education Initiative (REI) has revolutionized approaches to instructing children with learning problems (Davis & Maheady, 1991). This reform is aimed at instruction taking place in the regular classroom by the teacher with consultative support from the special education teacher. With shrinking resources and the need to fully implement core curriculum for all learners, the REI has required classroom teachers to consider methods of individualization and meeting unique needs of all learners in the class.

Technology in the form of the personal computer in the classroom and the school lab has opened doors to innovations in instruction for exceptional learners. This technology also provides avenues for the needed individualization requisite of a diverse group of students in the regular classroom. New devices and special software packages have been developed to increase accessibility for children requiring assistance in computer access. These include a continuum of products from very low-tech to very high-tech software, hardware, and instructional materials. The composite group of hardware devices, software programs, special materials, techniques of curricular and instructional adaptation, and ingenuity in application of these elements is considered access technology.

Often, the only road block to use of these innovations is the lack of preparation of the teachers, and a commensurate absence of confidence in attempting their use (Barh, C., Kinzer, C.K., & Rieth, H., 1991). The development of preservice (full courses) and in-service (workshops) on adapting computer-based instruction for exceptional learners is essential to empowering teachers. Once teachers have received training, disabling myth-based attitudes about the computer disappear, confidence replaces confusion, and teachers are enthusiastic about the use of computers in their classrooms. This benefits all involved, especially the child with special learning needs.

The Design of Courses in Access Technology

Participants who have completed a basic course in computer-based instruction for education are much better prepared for a course in access technology than those who have not. Much time (the first two to three meetings) must be spent on basics of computer literacy if students have not had a basic course before. It is not unusual to have a wide continuum of experience within the group attending class. Some students may, literally, have never turned on a computer before. Others may be very experienced in use of word processing, desk-top publishing, and a variety of software programs. This results in a very diverse group of students in the course.

The content covered in any special access course must cover information on a number of very important topics. These include personal philosophy, the use of multiple platforms, knowledge of basic hardware, configuration of special integrated boards and peripherals, software evaluation, curriculum adaptation for the special learner, and trouble-shooting skills.

The course must also be divided in terms of method of instruction. Part of the course must be lecture. In this way, technical information can be imparted. Readings from an appropriate text and helpful handouts in class can support the lectures. A heavy emphasis must be placed upon the use of time during class for hands-on experience with the equipment in order to apply the information that has been presented in lecture. Students should be working together in groups when doing class assignments. They learn a great deal from each other and enjoy activities more when working together cooperatively.

Lab exercises are critical to the overall acquisition and retention of information presented in class. When considering the points to be awarded in the course for various activities (exams, projects, labs), the lab activities should comprise more than half the points assigned. Students should be given time in class to practice requisite skills for completing lab assignments. However, they should have out-of-class exercises. This will require a great deal of organization on the part of the instructor. An open lab with all requisite hardware must be available. There should be a lab attendant who will sign out software and sign off on the lab sheet for various activities which do not result in a print-out or hard copy proof of completion (e.g. computer tours, simulations of telecommunications, etc.).

Content of the Courses

As mentioned above, the specialized content to be covered in a course on access technology for special populations is extensive. Essential elements are discussed below.

Philosophy

Time spent in conceptualizing a personal philosophy for use of technology in the classroom is very important. The students must also think about their attitudes relating to various disabilities, preferences for platforms versus the myriad of adaptive devices available across vendors, and their belief in flexibility in modifying instruction and the classroom environment.

Multiple Platforms

Third party vendors have created an abundance of adaptive devices to work with the personal computer products of many vendors. These include DOS-based, MacIntosh, and the Apple II families of computers. The ability to work with all three "platforms" is necessary. This includes formatting disks, booting and running software, inserting circuit boards, configuring disk drives and printers, and trouble shooting the equipment. This is a "tall order" for any one course. At a minimum, basic familiarity and minimal hands-on experience with all three platforms is essential to adequate preparation in technology for special populations.

Software Evaluation

Participants must learn the salient characteristics of good software for use with youngsters in the classroom. Checklists of attributes that warrant rejection of programs before purchase make up an important portion of the course. In addition to consideration of the technical aspects, information on categorizing software packages by virtue of the type of approach to instruction is important. This includes identifying software as drill-and-practice, simulation, games, problem solving, and reference. When making selections, teachers must learn to consider all aspects of software programs as well as the stage of learning in which the student is engaged in any particular content area of the curriculum.

Adaptations

Adaptations of the curriculum may be as simple as altering the number of problems a given child is expected to complete. At a higher level of sophistication, authoring programs and mini-authoring shells (e.g. Tutor Tech and Spellavator) can be employed to individualize a student's work more effectively. Several sessions should deal with these skills with commensurate lab exercises in software evaluation and adaptation for individual learners.

Trouble-Shooting

The ability to "figure out what is wrong" before calling in the technician (if there indeed is one) is requisite of any well prepared teacher using technology in the classroom. Many times, this can be as simple as checking cables and connections at the wall outlet. Re-seating integrated circuit boards, checking printer-drivers, and inspecting daisy chains of disk drives are higher level skills that must also be acquired. This content is of the utmost importance, and includes some of the most empowering information in any course on computer-based technology.

High-Tech, Low-Tech, and No-Tech

Materials used in any computer lab for regular or special education run the gamut from very high-tech to very simplistic no-tech materials. An example of high-tech hardware and material is a braille printer and the hard-copy braille output that it produces. No-tech materials can include the use of light filters (clear acetate colored report covers) that can assist in improving contrast on blue ditto copies. Teachers must be encouraged to realize that they have already come up with many low-tech and no-tech approaches to adapting instruction on their own.

Evaluation Component

Every course must contain an evaluation component. This is usually comprised of several measures including written exams, practical exams, a series of required lab exercises and a project.

Exams

Two written exams are usually required. This provides the opportunity to check for assimilation of factual information. More important is the inclusion of practical exams. This includes the requirement of completing checklists on the use of all three computer platforms and requisite skills in formatting disks, managing files, booting and running software, installing boards, configuring peripherals, and other relevant skills.

Lab Exercises

Students should receive a lab folder in which to keep the hard-copy print out of all their lab exercises. A lab sheet including columns for signature by the lab assistant for assignments which do not yield a print out is also included. Students can keep track of their own work, but the folder should be checked by the instructor periodically. If possible, the folders should not leave the lab, but be kept in a class file box. Students may keep extra copies of their work for insuring a record of their efforts. There should be one lab exercise for each three hour class meeting (given a semester course). Workshops can yield several products for a one-day session.

Project/Technology Plan

The recommended project for this course is a technology plan for the design of a computer center within a given classroom or for a computer center for a school, agency, or region. This reality-based project is accomplished by teams of students who must work together in cooperative groups. A detailed format for the project report is handed out at the beginning of the semester. The format of the project resembles a grant proposal. Time is allowed in several class sessions for group meetings and for seeking input from the instructor. This project has been a big hit with the teachers as it provides first hand, practical experience in grant writing.

Cooperative Learning

Although the use of computers has increased in special education classrooms across the country, the number of computers has not. A report from the Office of Technology Assessment (1988) provides data indicating that there is about one computer for every 30 students enrolled in public schools in the United States. With increased computer mediated instruction, the need to have children working together at the computer has increased (Barh & Rieth, 1991). Studies have netted results indicating that the average student participating in a cooperative learning situation performed better than students in competitive or individualistic learning situations (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981).

Embedded within the design of any course in computer-based technology for special populations or educational technology is the need for participants to work cooperatively together. In-class activities require students to work together sharing one computer. Much cross-pollination ensues as teachers share their knowledge, past experiences, perceptions and ideas with each other. Students also get together outside of class during open lab to assist each other with lab assignments.

Preparation of the technology plan requires students to work together in groups of four. They must divide up the work and plan for their combined group of youngsters while addressing all the unique individual needs represented in that consumer group. This makes for some very lively discussion, especially when formulating the budget. The participants develop very extensive plans that, usually, are much more comprehensive than those generated by individuals working alone.

Curricular Implications for the Classroom Teacher

The integration of diverse learners into the regular classroom has intensified the need for the classroom teacher to adapt instruction. Individualization of instruction is more the norm than the exception. Through the use of computer mediated instruction, many unique learning needs can be addressed. The modifications which have previously been considered "special education" are now just as relevant for the students across the regular classroom group. Specialized software enhancing print on the screen is highly motivating for many learners, not just those with a visual impairment. Talking software and the various voices provide motivation to read through listening for all children, not just the learning disabled. Voice activated technology will address the access needs of many individuals, not just the physically challenged. Flexibility, ingenuity, and creativity in curriculum adaptation and educational planning are limitless when considering the myriad of products on the market.

The classroom teacher involved in access technology and adapting curricula for a diverse group of learners will be empowered to facilitate success through innovation. These varied approaches to instruction will assist all learners, including those with special learning needs. By enabling those with disabilities, the learning experience of all others involved is enhanced. Truly, access technology has value for all students—not for special education.

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Moving beyond the calculator: Spreadsheets in elementary and middle level mathematics

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Introduction

The National Council of Teachers of Mathematics (NCTM) (1989) recommended that computers be integrated with mathematics instruction at all levels including the elementary and middle grades. Computers could, among other things, provide: a) an instructional platform for the introduction of new content, b) a powerful tool to free students from the drudgery of computing numbers so they can focus on higher level thinking skills, c) a connection between the concrete and the abstract through dynamic visual displays, and d) varied problem solving situations and applications.

As teachers' access to computers and opportunities for computer training increases, the amount of computer use in classrooms is also increasing. However, data indicate that many teachers who utilize computers in their classrooms tend to focus almost exclusively on drill and practice software (Cardelle-Elawar & Zambo, 1991). The emphasis on drill and practice is not surprising in light of Willoughby's (1990) finding that more than 90% of instructional software is designed to train the user in some specific low level skill. Using computers as a medium for drill and practice is contrary to the NCTM's vision of classroom computer use and the emphasis on lower level skills is inappropriate for quality mathematics instruction.

One type of program not usually thought of as instructional software has many applications in the mathematics classroom. The spreadsheet, thought of as a tool for finance, is commonly available and can be used as a tool for processing information and performing calculations to investigate mathematical relationships and solve problems. Spreadsheets are ideally suited for many of the types of activities envisioned by the NCTM. Spreadsheets can: a) provide students with a powerful tool for performing tedious computations freeing them to engage in higher level thinking, b) generate patterns helpful for understanding mathematical relationships and concepts, c) provide students with an opportunity to ask "what if" questions and see the results of their choices immediately, and d) introduce students to concepts of algebra by demonstrating the use of formulas and equations.

In spite of the great potential for spreadsheet use in mathematics instruction, the literature discussing potential applications is limited. A search of ERIC from 1986 to the present identified fewer than 20 articles addressing the use of spreadsheets in elementary and middle level mathematics instruction. None of the articles were research oriented. All of the articles promoted the use of spreadsheets and presented specific examples of their use in the classroom. The content of the described activities was diverse and included such topics as: making sense of large numbers, keeping financial records for a classroom token economy, keeping records for studies dealing with probability, estimating quotients for and solving long division problems, doing complex calculations, investigating Fibonacci series, generating patterns for the discovery of mathematical relationships, solving word problems, and solving equations.

The described uses of spreadsheets can be classified into two major groups: a) using spreadsheets for solving problems and finding the solutions to equations, and b) using spreadsheets to generate patterns of data for the exploration of relationships and numbers.

This paper will describe some of the suggested activities and briefly discuss some considerations for the implementation of spreadsheets in elementary and middle level mathematics instruction.

Solving Equations and Word Problems with Spreadsheets

One use of spreadsheets in mathematics instruction is for the solution of equations and word problems using a trial and error approach. The efficiency of the trial and error approach is increased by the spreadsheet's capability to display multiple calculations simultaneously.

Solving Algebraic Word Problems

Arad (1987) described using spreadsheets for solving algebraic word problems. He offered that teachers should approach algebraic word problems through the application of heuristics. Teachers instruct students, among other things, to set up tables, to write equations and solve equations, and to check the reasonableness of their answers. Arad suggested that solving problems with a spreadsheet requires students to follow similar steps. Consider the following word problem.

> Henry has twice as many quarters as dimes and the value of all the coins totals \$9.60. How many dimes and quarters does Henry have?

Solving this problem with a spreadsheet involves creating a template that calculates the number of quarters and computes the total value of the quarters and the dimes, when a value for the number of dimes is entered. Arad (1987) stated that it is reasonable to expect that the template will be organized in the form of a table and that the cells of the table will contain equations that in combination represent the problem. After the template is created, students solve the problem using a "trial and error" approach. That is, the students enter values for the number of dimes until the total value of all the coins is equal to \$9.60. During this process the students must compare the results to the desired goal of \$9.60.

Solving and Graphing Quadratic Equations

Equations can be solved in a similar manner with a spreadsheet. McDonald (1988) discussed using spreadsheets for exploring and solving both quadratic equations and systems of equations. Both processes involve guessing a value for a variable and then reguessing after considering the results obtained with the previous value.

For example, a student can find the roots of $X^2 - 2X - 3 = 0$ by creating a spreadsheet template that calculates the value of $X^2 - 2X - 3$ when a value for X is entered. Through systematic evaluations, that is, by systematically entering values for X, a student can discover which values for X will result in $X^2 - 2X - 3$ being equal to zero. Those values are the solutions to the equation. Although irrational roots are not identifiable with this method, close approximations of irrational roots can be attained by using the trial and error approach.

Inspection of the data generated in the search for the roots also enables students to find the minimum/maximum value for the function. Spreadsheets which have graphing capabilities can easily display the results of the repeated systematic evaluations as a graph. This visual representation provides students with an opportunity to conceptualize the meaning of "roots" to quadratic equation and also the meaning of minimum/maximum values without the burden of repeated paper and pencil calculations at different values of X.

Solving Systems of Equations

McDonald (1988) described a similar technique for solving a system of two equations with two unknowns. A template is created which will solve each of the two equations independently for "Y" when a value for "X" is entered. To solve both equations simultaneously the student must find the value for "X" which yields the same "Y" in both equations. Once the template is constructed, the student can once again proceed in the trial and error manner until the correct value is found.

Division

Dubitsky (1988) described the use of spreadsheet for solving division problems. She contends that many students have difficulty with the long division algorithm and become lost in their computational efforts so that they never fully understand the concept. Consider the following problem.

> 744 computers were shared equally among 8 schools. How many computers did each school receive?

Dubitsky (1988) recommended solving this problem by constructing a template into which the student enters a value for the number of computers given to each school. The spreadsheet calculates both the total number of computers distributed based on that entry and the number of computers that would be left over. Students solve the problem by guessing the number of computers to be given to each school and then revising their guesses based on the outcomes. Edwards and Bitter (1989) suggest a similar approach to solving problems that involves operations other than division.

Open-ended Problem Solving

Hoeffner, Kendall, Stellenwerf, Thames, and Williams (1990) described using spreadsheets for solving problems which typically are not solved algebraically but that require a substantial number of calculations. In one example, the students are required to plan a party. They must determine the amount of money to charge students for tickets to the party so that enough money will be collected to pay for the party supplies. After the creation of the template, the spreadsheet allows the students to explore several options in terms of decorations and choices of food before choosing a solution. Freed from the tedious computations needed to determine the results of the various options, the students can concentrate on evaluating the outcomes. Without the power of the spreadsheet, the large number of required computations would become tiresome and the focus of the problem would change dramatically.

This type of problem solving situation is quite different from those previously described. The problem does not have one correct answer that can be found by trial and error. Instead, there are an infinite number of possible solutions. The spreadsheet allows the students to consider options before choosing the solution they judge as the best.

Troutner (1988) suggested similar financial analysis activities, for example, investigating projected income and expenses from a school car wash to determine a reasonable charge per car. This is also a divergent problem and the use of the spreadsheet does not result in the discovery of the one correct answer but allows for the analysis of various options.

Exploring Numbers and Relationships

The second type of activity suggested for spreadsheets deals with the generation of data to investigate numbers and mathematical relationships. Parker and Widmer (1991) edited a compilation of activities to help children develop a sense of large numbers through the use of spreadsheets. Consider the following question.

> If your heart beats one time every second, how long will it take your heart to beat one million times?

The number 1 000 000 is difficult to comprehend. A template that converts beats per second into beats per minutes into beats per hour and so on, can provide the answer to this question and help students to attain a feel for the amplitude of large numbers. Knowing that it takes over 11 days for your heart to beat 1 000 000 times helps in understanding the magnitude of one million. Similar questions using very large or very small numbers were also suggested.

Vernot (1968) recommended the use of spreadsheets to help students understand concepts such as averages. A template can be constructed that keeps a running average of numbers as they are entered. By entering numbers and observing their effects on the average, students can make conjectures about the relationships between the numbers and the average. For example, they might discover that if a number is entered that is higher than the average, the average will increase, or that the more numbers that are being averaged the less effect each additional number has on the average.

Other simple spreadsheet templates can be created to generate data to serve as a focus for students' examinations of relationships. For example, a spreadsheet could display powers of ten and their equivalent standard numerals. This data could lead to understanding the relationship between the whole number powers of ten and the number of zeros in the equivalent standard numerals. The same activity could help students to develop a deeper understanding of place value. Although identical data could be generated with calculators, spreadsheets have the capability of displaying the results of several trials simultaneously to encourage the search for patterns without the need to record the results of individual trials.

Other examples of spreadsheet explorations include: investigations of the measure of the interior and exterior angles of regular polygons with various numbers of sides (McDonald, 1988) , the effects of doubling and redoubling a given number, the generation of Fibonacci series and the proportions between consecutive terms (Verdeber, 1991), and the fluctuations in the volume and area of figures when dimensions are varied.

Conclusions

Spreadsheets are widely accessible and powerful tools that can be used to present and explore a broad variety of mathematical topics at various ability levels. Because of the versatility of spreadsheets, teachers should be trained in their use and be provided with the opportunities to explore their various applications. Spreadsheets can provide teachers and students with the means to solve problems and explore mathematical relationships in a manner consistent with the recommended goals of the NCTM.

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Teacher educators' uses of computers in teaching

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Education majors who become teachers report that they do not feel prepared to integrate technology into their instruction when they are employed in schools. This indictment of our teacher preparation programs is revealed by a survey conducted by the Office of Technology Assessment (OTA, 1988). The data indicated that although 89 percent of all schools of education offer some form of computer training for their students, two-thirds of the graduates of teacher preparation institutions did not feel ready to use computers in teaching. These data are somewhat disheartening to teacher educators who struggled for a decade to prepare future teachers to instruct with technology. As we look back over the decade and assess our programs we must ask why we have not succeeded to the degree we might wish. One conclusion was reached by the editors of Electronic Learning (1991) after an analysis of their survey of deans, faculty, and computer coordinators at the 15 largest U.S. schools of education: ". . . technology does not permeate a student's typical preservice education experience, and that is a major impediment to technology use once they become teachers." (p. 21)

Our professional societies, International Society for Technology in Education (ISTE) and National Council for the Accreditation of Teacher Education (NCATE), have adopted competencies that we seek to develop in preservice students. Previously, I discussed a preservice model (Wetzel, '92) to develop these competencies. The model contains a combination of these components:

I. A three semester hour core course in computer applications and issues that can be a lower division university requirement or an education department requirement.
II. Professors who model uses of the computer in their courses by
    a. Using presentation programs
    b. Presenting lessons integrating subject specific software
    c. Requiring students to evaluate software and microteach using software
    d. Requiring students to use computer applications (word processing, database, and spreadsheet) throughout their content and methods courses to complete course assignments.
III. Field experiences with supervising teachers whose students use computers in their classes or in a lab.

I am aware of the debate between those who think that the first component, a core course, is vital and those who think that core course competencies should be taught within methods and content courses. Whatever our differing positions might be on this question, we must agree that the second component, that of having content and methods instructors integrate the computer into their instruction and require that their students do the same, is vital. If we want education majors to feel well prepared to integrate technology into their classrooms, then we should provide faculty models who do that themselves. This paper reports on a survey of faculty members designed to provide data related to professors use of computers in their classes.

A review of the literature on professors use of computers and technology in their teaching reveals a simple fact: most don't. Based on their 1990 case study, Grant and Geske conducted a case study of 21 tenured and untenured faculty in a department of journalism and communication and found "... there is little evidence that journalism and communication faculty are ... integrating the computing technology into their teaching function." Berenson and Stiff (1989) surveyed 25 undergraduate science and math faculty participating in an National Science Foundation (NSF) study and 60 of their colleagues from two colleges who were not participating in the NSF study. The researchers report that prior to the project most faculty members had not used technological tools for undergraduate instruction. For example, 67 percent seldom or never used the computer as a classroom demonstration tool. How did the faculty use computers? The most frequent use of computers was word processing. Eighty-two percent reported writing articles or reports with it. Only 13.9 percent of faculty made assignments that required their students to use computers and only 10.4 percent developed computer applications for their courses.

What are some of the reasons faculty members do not use computer/technology in their teaching? Jacoboson and Weller (1987-88) surveyed faculty of the School of Humanities of the University of Illinois at Urbana and found that 96 percent of respondents were interested in using computers, and that 60 percent considered lack of training an obstacle to computer use in research, professional activities and teaching. Staman (1990) reported on the action plan for infusing technology in the teaching/learning process at West Chester University. He believes that obstacles include lack of awareness of the potential offered by technology and a dearth of successful examples of use of technology in all disciplines. Staman also described fundamental faculty concerns such as the place technology plays in the restructuring of the classroom. After conducting a microcomputer infusion project, Rossberg and Bitter (1989) summarized the attitudes of those not interested in using computers for instruction: 1) the computer was not a time saving device until one has mastered it; 2) technology was viewed as a dehumanizing device; 3) staff did that kind of work for them; 4) many were simply afraid of the computer.

Method

The survey population included all faculty in the education unit at Arizona State University West Campus, a new branch campus of ASU The education unit includes 28 faculty in educational psychology, administration, foundations, and curriculum methods. The survey was sent out to obtain baseline data that would allow us to ascertain where we are, how far we have to go, and perhaps lay the foundation for a discussion of the part we want technology to play in our program. I asked faculty what they are presently doing in their courses and what they would like to do in the future. Surveys were sent to 28 faculty. Seventy-five percent (21) returned the survey.

The questionnaire consisted of 16 questions covering current uses of technology in the classroom, possible future uses and obstacles to further use. The questions regarding perceived obstacles to further use and other concerns of the faculty were open ended. This allowed faculty to express as many and as varied concerns as possible.

The survey was to provide information for improving our integration of computers into teaching and learning. I was particularly interested in gaining specificity about current uses of technology in teaching, insight into what they would consider doing in the future, and the obstacles that prevented them from making progress. I asked specifically about the modeling of tasks that professors were doing.

Findings

Twenty-one faculty members returned surveys. Of these, 4 (10%) stated that computers have no role in their classes (Table 1). Responses from the remaining faculty were divided into two groups: those currently using them and those not using them, but interested in doing so.

Current Use

Faculty who use computers in their classes were asked to indicate how they use them. The largest percentage of the faculty (81%) recommend (orally or in syllabi) that students use productivity tools to do the work for their courses (Table 1). In this category, most often faculty recommend that students use word processing to write papers, lesson plans and design materials (overhead transparencies). To a lesser extent they recommend using tools for data analysis (24%), telecommunications (5%) and music notation (5%). Only one faculty member requires students to evaluate software and only two faculty members demonstrate instructional software in their courses. The other uses of the computer that faculty listed include: computerized Individualized Educational Plans, computer-based problem solving, and behavior management tools.

Table 1
Computer Uses Modeled in Classroom: Presently Used, Interested in Using and Combined Use

	Currently Use		Interested in Using		Total	
Uses of Computer in Classroom*	%	(n)	%	(n)	%	(n)
Lecture and discussion tool	19	4	29	6	48	10
Demonstrate instructional software	10	2	43	9	53	11
Software evaluation assignments	5	1	48	10	53	11
Recommended: Students use tools to do assignments	81	17				
Required: Students use tools to do assignments			81	17		
Other uses in classroom	33	7	14	4	48	10
Computers have no role in my course	19	4	5	1	24	5

*n = 21

Interested in Using

In this group are responses from faculty who would *like* to use computers in their classes, but do not presently do so.

Five of the current use survey questions were repeated for interested in using. Two questions were reworded: "Do you recommend that students use productivity tools to do the work for your course?" was changed to "Would you require that students use productivity tools to do the work for their courses?" Once again, the largest percentage of faculty indicated a willingness to require students to use computer tools to complete assignments if the students had adequate access to computers at home or university and a working knowledge of the tool software required. Other responses on ways to use computers in the classroom included: to model [lessons integrating computer use] for my students; demonstrate how children can learn a second language through computers and demonstrate usages for bilingual/ESL teaching; and develop interactive video lessons on infant development.

The other reworded question: "Do you demonstrate instructional software as another form of media?"was changed to "Would you demonstrate instructional software if you had access to a variety of software in your area?" Forty-three percent of the faculty indicated an interest in demonstrating software in their classes if it was available. Also, 48 percent of faculty were interested in having their students evaluate software (Table 1).

Combined Current Use and Interest in Using

Looking at the data gathered from both those presently using and those interested in using reveals that most faculty members are recommending that students use appropriate computer tools to do assignments and they are willing to require students to do so given the right conditions. About one-half of the faculty are demonstrating or are interested in demonstrating appropriate uses of software in their classes, requiring students to evaluate instructional software, and using lecture and discussion tools (such as Aldus Persuasion).

Obstacles

As noted above, not all faculty are interested in using computers in their classes. Further, even those who are using or are interested in using computers report barriers to use. Seventeen of 21 respondents cited obstacles which fell into three general categories: 1) lack of information, 2) lack of time or no room in the curriculum to add anything new, and 3) lack of software or equipment.

Discussion and Implications

The findings concerning the faculty who use or are interested in using computers in instruction are encouraging. The survey results indicate a high degree of willingness to ask students to use productivity tools and evaluate software, and for faculty to personally use computer based presentation tools. Although only one faculty member is presently demonstrating instructional software and only two require students to evaluate instructional software, about 50 percent indicated they are interested in doing so in the future. Comments of faculty members also illustrate an interest in doing more in their content areas to prepare preservice students to teach in the information age.

The obstacles to teaching with computers revealed by this survey parallel those found by Jacobson and Weller (1987-88). They found that 60 percent of the humanities faculty felt a lack of training was an obstacle to computer use in teaching, research and professional activities. To a lesser extent, faculty also thought hardware and software were obstacles.

Some of the barriers cited were no surprise. The faculty I surveyed have one of the best facilities around, yet they continue to cite problems with lack of software or equipment. A close reading of their comments seems to indicate that most of these concerns center on a lack of software in their particularly discipline which may well be the case. Only a few expressed concern about access to equipment. Faculty also made comments that centered on lack of time to obtain information themselves and to add computers to an already full class time.

Most revealing were the many comments grouped under lack of knowledge. It appears that it is not just technical knowledge that the faculty lack, but a knowledge of how to use the computers in instruction. All of the faculty surveyed have computers in their offices and use the computer regularly as a personal tool. With the exception of urging students to use word processing to do their assignments, however, the majority of faculty members do not teach with computer technology. This may be because many faculty do not have a vision of why and how to use computers in the classroom.

Although personal computer literacy may provide a valuable foundation for computer applications in teaching, this survey revealed that there is a sizable gap between personal computer use and use in teaching. Our challenge is to provide a clear vision of how computers and technology can transform classroom instruction. As Kozma and Johnson (1991) stated Computers will have their ultimate impact only when faculty members are presented with vivid images of how computers will change the classroom and changes what students do when they study. (p. 23)

The purpose of this survey was to provide information for improving the integration of computers into teaching and learning at ASU West Campus. I was particularly interested in gaining specificity about current uses of technology in teaching, insight into what faculty would consider doing in the future, and the obstacles that prevented them from making progress. This survey provided me with some insights into the need to develop a vision of what is possible. The need for training support is also evident. I found the number of faculty members who were interested in exploring this area to be heartening. Others seeking to influence change in their departments may wish to consider developing a survey to provide a base of information to begin the planning process for change.

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Centers for professional development and technology: CEDE in San Antonio

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In January, 1992, the first drafts of the Texas Education Agency's call for proposals for the planning of Centers for Professional Development and Technology appeared. Educational institutions throughout the San Antonio metropolitan area involved with preservice and inservice teacher education programs began meeting with community organizations to discuss mechanisms that might bring them together in collaboration in order to establish a community-wide professional development center. During the ensuing months: (1) prospective members of such a collaborative met; (2) a planning grant to develop the entity was written and funded by the Texas Education Agency; (3) a working conference for all members of the proposed collaborative was held to develop premises on which a Center would be based and formulate practices for it; (4) a community-wide conference that included presentations on professional development and the integration of state of the art technology in educational settings was conducted; (5) a governance structure that ensured both teacher participation and representation was prepared; (6) a community-wide needs assessment that helped determine the professional focus of a Center was conducted; and (7) a dissemination and evaluation model for the Center was constructed. As a result of these endeavors, the Center of Educational Development and Excellence/Centro Educacional para el Desarrollo y Excelencia (CEDE) was formed.

Members of the CEDE Collaborative

The charter partners from the greater San Antonio area that, working together, created CEDE are faculty, staff, and administrators from: Edgewood Independent School district (Edgewood ISD), Incarnate Word College (IWC), Our Lady of the Lake University (OLLU), Providence High School (PHS), Northeast Independent School District (NEISD), Northside Independent School District (NISD), Region 20 Education Service Center (ESC-20), St. Anthony School (St. Anthony's), St. Martin Hall School (ST. Martin's), St. Mary's University (St. mary's), St. Peter prince of Apostles School (St. Peter's), San Antonio (Community) College (SAC), San Antonio Independent School District (SAISD), Trinity University (TU), The University of Texas at San Antonio (UTSA), The University of Texas at San Antonio Alliance for Education (UTSA Alliance), and members of the San Antonio business community (see Figure 1). It is planned that, as the Center evolves, additional representatives from public and private schools, as well as diverse community businesses and organizations from throughout South Central Texas, will be added.

CEDE Objectives

CEDE is committed to building on the multicultural characteristics and heritage of the San Antonio community—a tradition not just of accommodating and assimilating but of celebrating the richness of its diverse cultures. The Institute of Texas Culture's research division estimates that there are more than 50 different culture groups represented in San Antonio's population. Some are organized formally; others are present in less formal, familial, neighborhood, and community groups. Many community agencies offer ways for city residents and visitors to interact with the traditions of different culture groups and to participate in events that mark special values, celebrations, or holidays of the various cultures.

From its onset, CEDE collaborative planners insisted that the Center must, first and foremost, develop teachers in settings that reflect San Antonio's cultural richness and, further, that those teachers must be prepared to create classroom environments in which all students are effectively integrated and in which diversity is valued and celebrated. It is the collaborative's belief that such efforts, including access to technology literacy and competency, will result in more equitable access to rich educational experiences for all students.

CEDE sites will be selected to represent the ethnic, social, economic, and cultural diversity of the area. Public schools and Catholic private schools that contain a representative cross-section of the South Texas population are included in the center and will be the setting for much of the preservice preparation of teachers. The members of CEDE also recognize that they have a responsibility to include the wide range of schools, as measured by achievement standards from high to low performance levels, within the newly structured educational programs it will develop.

Individual schools within the Center will focus on approaches—including technology—that more effectively involve students from all area cultures, abilities, and backgrounds in effective learning communities. Specific efforts will be directed towards the recruitment of minority teachers to adequately represent the diversity of the area. CEDE will facilitate and encourage dissemination of effective and innovative pedagogical approaches, both within the CEDE network and to the broader educational community.

Within the greater San Antonio area there is a strong commitment to educational reform, restructuring, and improvement. Chosen as one of the first America 2000 cities by U.S. Secretary of Education Lamar Alexander, the San Antonio educational community is committed to achieving the six national goals outlined in America 2000. The establishment of CEDE is a natural progression of a community-wide commitment in bringing the best educational opportunities to all the citizenry of San Antonio and South Texas.

CEDE, thus, will build on long-standing traditions in San Antonio, while at the same time take advantage of its unique opportunity to accomplish important educational goals for the students and teachers of San Antonio and Texas. Specifically, the objectives of CEDE are to:

1. Create a variety of Professional Development Schools (PDS) that are exemplary environments for educating the students and teachers of San Antonio and South Central Texas.
2. Create teacher education experiences in PDSs in which preservice teachers have a chance to work closely and over an extended period of time, on site, with PDS coordinators, mentor teachers, and faculty from participating institutions of higher education (IHE).
3. Allow, for the first time, the movement of preservice student teachers from one PDS site to another for clinical and content experiences, regardless of their IHE registration.
4. Develop the technical competence (knowledge and skill) of members of the collaborative and teacher education students in CEDE programs.
5. Increase the access to cutting edge instructional technology for members of the collaborative and teacher education students in CEDE programs.
6. Increase the degree to which technology is an integral part of instruction in teacher education programs and the school classrooms of San Antonio and South Central Texas.
7. Increase substantially the number of teachers who effectively teach culturally diverse students, especially Mexican American Students,
8. Recruit and increase substantially the number of ethnic "minority" teachers in San Antonio area schools.
9. By September, 1993, the collaborative will develop a plan and identify sources of funding for ensuring continuation of CEDE.
10. By September, 1994, CEDE IHEs will submit revised teacher education programs to the appropriate state agencies.

New Directions for CEDE: Building-On and Beginning Activities

The results of the needs assessment shaped the content, evaluation, and dissemination philosophies of the CEDE collaborative and helped focus on the types of activities each IHE would bring and add to each CEDE PDS. CEDE partners bring to the collaborative continuing and newly formed professional development activities between the IHEs, the schools and school districts, the Regional Service Center, and the other community-based entities that are charter members of CEDE. Each institution within the collaborative has had strong field-based components in its preservice teacher education programs, as well as ongoing involvement with continuing professional development action plans. This involvment will initially allow each university to build upon current efforts and offer students expanded intellectual opportunities through joint educative processes. As CEDE programs unfold, new types of certification designs will emerge (by Fall, 1994) that take advantage of expanded, jointly shared, responsibility for professional and technology-related training through a collaborative model.

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Strategies for teaching a large undergraduate course on educational computing

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There is increasing pressure to integrate coverage of many aspects of information technology into all areas of the K-12 curriculum. However, at many institutions, the focal point of information technology (IT) coverage remains the stand-alone "educational computing" course. In the early eighties that course was often used to teach preservice teachers to program in languages such as BASIC or Logo. Later in the eighties the course generally required students to learn operating system commands and other "computer literacy" topics such as word processing.

Today many of the stand-alone courses attempt to cover many topics including basic computer literacy, curricular integration of IT, and the use of emerging educational technologies such as CD-ROM and computer-controlled laserdisc players. The overall goal of these courses is to empower pre-service teachers and encourage them to plan for the integration of technology into the routine of their classes when they graduate.

Educational computing, as a new kid on the academic block, comes to teacher education at a difficult time, economically, for higher education. Educational computing courses are being added to the teacher education curriculum, becoming required instead of optional, and expanded on many campuses at the same time many institutions are dealing with serious budget shortfalls that call for retrenchment rather than expansion. Like many universities, the University of Houston (UH) is dealing with difficult and unstable economic times, but it requires approximately 250 undergraduate teacher education students a semester to complete the required educational computing course. That number may, in fact, increase as the staff who evaluate transfer courses learn that courses previously accepted in lieu of the educational computing course (such as a COBOL course taken in 1968 and a WordPerfect course taken at a community college in 1987) are not acceptable substitutes.

If the UH College of Education staffed the required educational computing course at the same level as typical lecture/discussion courses (e.g., 20-40 students in each section) the course would require the full time attention of at least four faculty every semester. UH, like many universities, has a small IT faculty. Only two full-time faculty are assigned to the program and they must teach all the graduate courses as well as supervise or teach the undergraduate educational computing course. The problem of high demand and low staffing is a common one for this course which is relatively new and has become a required course during a period of retrenchment in higher education. Troutman and White (1991), for example, developed an EC course under just such circumstances at the University of South Florida. Their course uses a differentiated-staffing model that involves staff with different types and levels of expertise in different aspects of the course. The course also uses traditional and computer-controlled multimedia to deliver some of the instruction, and several rooms were renovated to serve different needs. A course with similar objectives was developed at Texas Tech University (Frisbie, Harless, and Brunson, 1991). This course divided the content to be taught into a series of modules students could complete at their own pace. The Texas Tech course is a precursor to the one we will describe in this paper. Both are based loosely on the PSI model.

An Overview of PSI

F. S. Keller's Personalized System of Instruction (PSI) was introduced almost 25 years ago. Keller, a close associate of B. F. Skinner, developed PSI while working at a new university in Brasilia, Brasil. He described his method in an article titled *Good-Bye Teacher* (Keller, 1968). Although this unfortunate choice of title suggests it is an effort to eliminate the need for a teacher, our own experience as well as that of others indicates the instructor plays a crucial role in the success of a PSI course.

PSI is a student-centered, self-paced approach to teaching and learning that requires instruction to be packaged in *modules.* This instructional technique is in sharp contrast to the predominant mode of instruction since the emergence of the modern university: the lecture.

What Is PSI?

Keller used behavioral learning theories, specifically applied behavior analysis, as the basis of his Personalized System of Instruction. The behavior analysis roots of PSI are evident in its adherence to two important aspects of teaching - a clear description of what is to be learned (terminal behavior) and effective management of rewards for study (positive reinforcement).

Basically, constructing a PSI learning system is quite elementary. The course objectives are identified, and the content of the course is broken into distinct modules that are more easily studied by the students. Within each module, the objectives and procedural instructions are clearly written. The modules as well as study or course guides are then printed and made available to the students. In a pure PSI system students can choose any of the modules to study in any order, but a certain quantity of modules must be completed to achieve a particular final grade. Within these guidelines, however, fine tuning the procedures until they work for specific instructional requirements is necessary.

All PSI instructional systems share a set of features that are characteristic of the technique. The basic features of the instructional technique include detailed instructional objectives, frequent tests or evaluations, proctors who help students work through the modules, an emphasis on subject-matter mastery of each subject attempted, and student-determined progress (Ryan, 1974). The following discussion describes these features in detail.

Detailed instructional objectives

In the initial course outline, the students must be told clearly what they will learn, why they will learn it, and precisely what progress is to be measured during the semester and how. In addition, the learning objective of each module (unit) must be clearly stated at the beginning of the individual module's instruction booklet.

Frequent tests

Frequent testing is a major component of the PSI system for several reasons. The primary reason for frequent testing is the commonly-held perception that students tend to cram before a test, a perception that is supported by research (MacWhinney, Bostow, Laws, Blumenfeld and Hopkins, 1971). By manipulating examination frequency, MacWhinney and his colleagues were able to increase or decrease the rate of effective student study behaviors. A second reason for frequent testing is the emphasis in applied behavior analysis on regular and precise observation of behavior as a means of assessing progress. In a PSI system the instructors keep track of the progress each student is making, and become aware of problems with modules, through the frequent tests.

Student proctors

Student proctors, sometimes called teaching assistants, tutors, or course assistants, proctors manage the course. The proctors administer tests, grade examinations, interface with students, and maintain records of the grades. Liberal use of student proctors may be the most radical characteristic of the PSI system. However, during this budget-conscious era in American higher educational institutions, using graduate and undergraduate students to assist in the PSI course is the most practical way to achieve the goal of educating the large number of students and ensure that individual attention is provided for each student.

Subject matter mastery

Mastery of a module (unit) is measured by either a test or completion of a project. Tests have to be passed at "mastery level" which is generally 80% or better if the test is multiple choice. A limited number of retakes are allowed, using alternative forms of the examination, and there is no penalty for failure on early attempts at the examination. The proctor is usually responsible for judging the quality of completed student projects.

Student determined progress

In a pure PSI course the student determines the pace of work. The student may wish to work rapidly through the assignments and finish the course early or may work around other obligations. The student only has to consider the deadlines that were pre-determined and communicated at the beginning of the course.

Advantages and Disadvantages of the PSI System

Smith (1986) reports that in comparison to more traditional lecture and Socratic dialogue teaching methods, PSI is viewed more positively by students and that the students' performance outcomes are higher. In a report summarizing the results of subjective student ratings, PSI scored the best in all of the following five areas: 1) Positive course-as-a whole rating; 2) Would recommend course to my friend; 3) Course rated as informative; 4) Course rated as enjoyable; and 5) Rated better than lecture system. Similar results were described by Freeman (1984) whose experiments focused on the long-term benefits of PSI versus traditional modes of instruction. He concluded that PSI students performed significantly better and also performed better in three subsequent courses in chemistry. However, PSI students had a higher tendency to drop out of the class. Kulik, et al., (1974) also concluded that, while the Keller Plan was favored over the lecture technique by students, controls for procrastination and higher-than-normal withdrawal rates were necessary. Smith (1986) recommends providing a schedule of dates by which certain modules must be completed, offering early course completion for passing units early, and requiring students to take the first unit test during the first two weeks of the course.

Procrastination is one of the most serious drawbacks of self-paced learning. Powers and Edwards (1974), cited in Lamwers (1989), found that students who started early also finished early. Lloyd was quoted, in the same article, as indicating that students who procrastinate also tend to withdraw from the class. Early identification and intervention may help reduce procrastination (Lamwers, 1989) and reduce the withdrawal and failure rate. For example, Ruthven (1984) compared three types of course structure. A self-paced group was required to complete the work by the end of the school term with no intermediate deadlines; the long contract group was required to complete a percentage of the work by a date late in the school term; the short contingency contract group was required to complete units of work at regular, early deadlines. Ruthven found that short contingency contracting and complete self-pacing (non-contractual) groups performed better than subjects in the long contract group.

Considerable effort has been invested in assessing variations on the basic PSI components. Some authors, however, have raised more serious questions about the quality of instruction, and learning, in PSI courses. Caldwell (1985) questioned the effectiveness of some aspects of PSI. He felt the combination of using predominately multiple choice questions to test mastery (a common procedure in PSI courses) and student proctors might be "dangerous" and could lead to simplistic, low-level learning as well as considerable cheating. Hobbs (1987) added that the module in a PSI course becomes the final authority and that the process of studying the module in order to answer multiple-choice questions will encourage memorization over critical thinking. Furthermore, Hobbs feared that PSI professors will use the proctors to minimize contact with students and reduce the amount of lecturing time. (It is not clear, however, whether fewer lectures is more strongly desired by the professors or the students.)

Questions that focus on the qualitative aspects of learning in PSI courses have been debated frequently in the literature (Caldwell, 1985; Semb and Spencer, 1976, Reboy and Semb, 1991). In their article in *Teaching of Psychology*, Reboy & Semb argue that the responsibility for course content lies with the professor in charge, who must decide the goals and objectives of a course. If the instructor integrates a critical thinking skills component into the content and then adequately assesses the skills demonstrated by the student, higher order cognitive skills are developed. Reboy (1987) cites evidence indicating that PSI has successfully been used to teach complex subject matter at levels of achievement exceeding achievement levels attained in a lecture-discussion format. While that argument is an effort to deflect criticism of the PSI approach our own experience suggests the criticisms are, to some extent, valid.

Tests are a critical component in a PSI course and the easiest type of test to develop and grade is multiple choice. And when creating multiple choice items it is much easier to create items that ask clearcut, factual questions. Questions that assess higher order thinking skills are much more difficult to write. In addition, objective tests are much better at assessing declarative knowledge, but teaching is a profession in which procedural and conditional knowledge as well as problem solving and metacognitive skills are critical to successful practice. There is the danger that a pure PSI course on educational computing may test students with questions that ask about the command for formatting a 720K disk in MS-DOS 6.2 instead of questions that assess the student's ability to integrate simulations into a lesson on the Irish immigration to the New World. In creating the PSI educational computing course at UH we have tried to take advantage of the economies of PSI while avoiding some of the pitfalls and disadvantages.

The Course Rationale

The required 3 semester hour UH educational computing course has several major objectives. Through reading assignments, hands-on activities, discussions, and projects the students are able to:

(1) develop an understanding of the role of the technology in our information intensive society;
(2) master the basics of operating a personal computer;
(3) develop an awareness of the diverse roles information technology plays in education; and
(4) learn how to integrate computer technology into the curriculum at the level and in the subject area they plan to teach.

This course, which has been operating for two years, replaced a computer literacy course that dealt primarily with computer literacy topics (operating systems, Microsoft Works, programming in BASIC and Logo). The course that was replaced required students to meet a two hour mass lecture each week (for about 190 students) and attend a 2-hour small group session in the computer lab where a graduate student helped students learn to use the Macintosh computer. Students disliked the large group lectures but liked the small group sessions, in part because requirements were relatively low and most students earned an A without a great deal of effort.

In revising the course our main focus was to develop a flexible curriculum to guide future teachers into exploring specific aspects of teaching with the assistance of information technology. Different learners require different teaching environments and strategies. In the same manner, diverse objectives call for diverse approaches to meet them. The result of our redesign efforts is a course that incorporates a number of PSI characteristics as well as many non-PSI features.

The Course Format

The required, large-group lecture has been eliminated entirely. During the semester students can, if they wish, attend some presentations made by experts in various areas of educational computing and they receive credit for attending. Houston has many innovative educational computing projects and invited speakers who are working on specific projects involving technology are an important aspect of the course. These professionals share with the students a pool of teaching strategies, professional experiences, and personal views on how to integrate the changing technologies into, across, and throughout the curriculum.

The rest of the scheduled times for the large-group lecture are set aside for troubleshooting. One of the proctors or the instructor of record is available during that time to help students with problems and answer questions.

Weekly Small Group Meetings. Most of the "action" in the course takes place in weekly two-hour small group sessions taught by graduate teaching assistants and held in the Center for Information Technology in Education (CITE). The Center has two IBM labs, a Macintosh lab, and a Classroom of the Future that is equipped with a range of information technology resources.

Each small group has about twenty-two students and a group leader or instructor who is a graduate student in the IT program at UH. During the small group session the instructors introduce selected topics and provide guidance. They act as facilitators and coaches by encouraging students and providing support. The students are also encouraged to work in small groups and to share knowledge whenever possible. Additional technical support is available during open lab periods as Center staff are familiar with the course and its requirements. Undergraduate students in this course are often anxious about both the content and their ability to master it, but we have developed a strong network of support that supports them both technically and psychologically.

PSI in its pure form may not take into adequate consideration the personal support needs of students who have limited computer backgrounds. In our course, many of the undergraduate students did not feel at ease with the self-study component. Left completely on their own to schedule work on the modules many will put off work until there is not enough time left in the semester to complete enough modules to pass with a C. The group leaders in this course serve as cheer leaders, supporters, coaches, counselors and guides to a much greater extent than might be expected in a traditional PSI course. They are also, of course, technical consultants and troubleshooters, but those responsibilities can also be covered by Center staff who are available many hours a week during open access periods. The other, less tangible roles the group leaders play are probably the most important in helping students select and complete assignments.

Very early in the semester, the students are made aware of the requirements and demands of this self-paced course. They know what is expected of them: commitment, hard work, and attainable goals. The pattern of student success has changed over the last three semesters that the new program has been in place. The rate of success in completing the course has steadily increased and is now setting new records.

Modules

When students meet the class for the first time, they have purchased a packet that describes the course and lists the modules available for them to study. A few modules (12) are required, but most of them are optional. Students who already use a word processor, for example, are not required to learn the one used in this course. Some of the modules are actually chapter assignments from the educational textbook used in the course (*Educational Computing: Learning with Tomorrow's Technologies* by

Maddux, Johnson, and Willis, 1992). Students study a set of chapters and then take a multiple-choice test over the material. Students can also select chapters from the series of topic and level specific educational computing texts published by Mitchell Publishing Company. Books on using computers in English, foreign language, mathematics, reading, language arts, and social science are available as well as a text on teaching higher order thinking skills.

Other modules require students to demonstrate mastery of different components of the Microsoft Works program on either the Macintosh or IBM computer. Students may purchase a textbook on Works (*Microsoft Works: Tutorial and Applications* by Willis, Pasewark, and Pasewark, 1991). Originally the students were tested for mastery of topics covered in this text by tests taken from the teacher's guide for this book. The tests were quick and easy to grade, but they were totally unsuited for the task. Currently students complete and hand in one or more applications assignment at the end of a chapter to demonstrate mastery of the content of that chapter.

Other modules are hands-on activities with 10 to 25 page guides developed at UH or other universities. Many of these modules can be completed in teams of two to four, but some require students to work individually. Quite a few modules are traditional print instructional materials, but several use tutorial software, multimedia, hypermedia, or simulations to deliver instruction. In addition, we have created several modules that require students to use a technology-supported instructional package for teacher education. Instead of simply reading about laserdisc-based simulations, for example, students can use one of the simulation/tutorials on classroom management or questioning techniques developed at the University of Alberta. They thus learn important professional content while they experience an important technology-supported instructional strategy. A sample of module topics includes:

- MSDOS basics - (a shareware tutorial program called TutorDOS)
- Macintosh Tour - (Apple-supplied tour)
- Macintosh Operating System Basics
- Using Videodiscs in the Classroom (a videodisc-based instructional package)
- CD-ROM applications
- Selecting and Evaluating Educational Software
- Using the ERIC CD-ROM to Locate Relevant Literature
- Creating Classroom Presentation Materials with HyperCard
- Locating and Evaluating Technology-supported Lesson Plans

Assessment

During our first semester we kept the once a week large group lecture. The instructor answered general questions from the students in the audience, introduced new topics, made reading assignments, and provided general guidelines for the course. Tests over required assignments were also conducted during the large group meeting. However, the large group meeting was not very effective and testing was difficult to conduct. Students who had never used computers before were very anxious. They needed constant assurance and support in order to succeed. The large group lecture was not an adequate environment for reassurance. Student-teacher interaction was limited and impersonal.

Currently students complete tests during the small group sessions each week. The Center staff and the group leader supervise this activity and while many of the tests are still in a multiple-choice format, we are trying to shift more and more to assessments that involve completing projects, demonstrating competencies, and finishing hands-on assignments. Developing these types of assessment strategies, and finding the time to meaningfully evaluate them, is difficult and we have not progressed as quickly as we had hoped. In addition, students can choose from over 120 different modules but they must pass 37 for an A. That provides students with considerable flexibility in content and emphasis, but it puts an additional burden on the course staff because they must be ready to assess every module that is available to students.

Scheduling

Scheduling, technical support, and resource maintenance have been the most delicate elements of our program. Computer labs in the Center are open for at least part of the day six days a week and initially the needs of almost two hundred eager students who need continuous support generated some conflicts between students and Center staff as well as between Center staff and course instructors. Part of the problem was a management philosophy in the Center that did not understand the roles of a computer center in a college of education (as opposed to a business school or a computer science department). The problem was also exacerbated by the fact that originally the Center staff came primarily from other departments on campus such as engineering and computer science instead of education. With the arrival of a new Director for the Center and the replacement of the center's manager with someone who was more service oriented conflicts have been reduced considerably. Graduate students in education, with preference given to IT students, now staff the Center and teach the courses. Students who need help can get it from their group leader during the 2-hour small group meeting each week or during any of the open lab times from Center staff.

Resources

Before the change in directors and managers at the Center the students completing the course were limited to using one networked lab of IBM computers using Novell and IBM's Classroom LAN System (ICLAS). During the first semester of implementation, only one ICLAS (IBM Classroom LAN System)was accessible for that class. A networked Macintosh lab was available only occasionally and the use of another PC lab very restricted. The limited number of stations available resulted in a large number of students working at home, at work, or at other facilities. Because the demands of the course had increased significantly it also meant many students who could only work in the Center's labs found it difficult to complete their work because they could not get enough time on the computers. Today, with additional resources added to the Center and a revised plan for use, students have access to two MS-DOS networked labs, one networked Macintosh lab, and a Classroom of the Future. The Classroom of the Future has several powerful Macintosh and IBM computers with CD-ROM drives and videodisc players. The room also has a hand-held scanner, sound synthesizer, sound digitizer, color projection panel, large S-video monitor, VCR, and one telecommunication station.

Discussion

As we have worked to develop an effective course that meets the needs of almost 200 students a semester with very limited personnel resources, we have come to realize that success in such a project depends a great deal on leadership and cooperation. In this case leadership cooperation from the Center's director and manager was crucial. Just as important was a commitment from the group leaders and instructor of record (a senior graduate student with experience teaching the course and an ability work effectively with groups). In addition, strong technical support from the manager of the Center as well as quick responsiveness when problems with networks, printers, and the like makes the difference between a disaster and a difficult but "passable" course.

Although there are many important components to this course we think the most important is the small group leader. At UH a group of dynamic teacher assistants act as liaison between each student and the curriculum. They are facilitators who provide the students with appropriate guidance and support. They guide the students individually to plan strategies for completion of the modules. During short presentations, the instructors motivate the students, present background information, introduce new topics, and demonstrate skills. The small group instructors' dedication and commitment are our program's best assets. This perspective is also supported by Martinez & Martinez (1988) who suggested that in their experiment "excellent" teachers do make a positive difference in PSI student achievement. The qualitative and cognitive aspects of our implementation of PSI seem to be much more important than the quantitative, behavioral aspects. As one of the graduate students who has worked in this program for several semesters put it, "One of the secret ingredients of our success with this PSI course is the outstanding quality of the instructors, not a "doomsday with token" nor "contract" mentioned in the PSI research. The driving force is really the relationship between the instructors (TAs) and their students. The instructors are passionate about their duties. We view ourselves as bridges between the course and the students, ambassadors for computer technology, and psychologists for weary students. We often will hang around the computer labs during our own time just to help; when the students are bombarded with work, the extra effort from the instructors is perceived as almost 'life saving'. One of the instructors blows congratulatory kisses and hugs her students (most of them are female) and the students send her flowers and work very hard in the computer labs. The same instructor will tell the students exactly how the students are faring: not patronizing, just confirming the truth. Because attendance for this class is not required, we are known to call students at home to provide extra help and push. Almost 70% of the students have clearly stated in their survey that the instructors in this course were particularly professional, helpful, skillful, and caring."

Another aspect of the course that differs from a pure PSI course is the large group meetings. Although attendance is not required guest speakers do make presentations throughout the semester. Lecture/demonstrations, despite some mixed reviews, remain one popular strategy for sharing data between the instructors and the large group of students. The question and answer period that follows the speakers' presentations have often been very interesting and useful.

Plan for the future

At the present, all assessment is done off-line. Students keep track of where they are on a Progress Chart supplied in their packet and the small group instructors keep a record of progress as well. Many of the tests and assessments could be computerized so that students could enter the Center, show their ID, and then complete tests on-line. Results would be available immediately and the student records for the course would be updated automatically. Automating testing and record keeping would allow small group leaders to spend more time helping students.

We continue to work on new modules and to revise modules already in use as student feedback helps us pinpoint problems that should be corrected. We are working on an educational telecommunications module, for example, that should be in use by the Fall of 1994. In addition, we are working with other teacher educators to develop and distribute instructional modules electronically through the Society for Technology and Teacher Education's Internet server. We may be nearing the saturation point, however, for students in this course. Although the informal reputation of the course before it was revised was "easy A" the PSI course was recently rated as "Very Hard" in a student survey. Each semester at least some students conclude early in the semester that they cannot possibly complete enough assignments to pass the course. We credit our small group instructors with the fact that the great majority of students do pass, and there is not the high percentage of drops found in many pure PSI courses.

The future of this course, in terms of content, is perhaps a continuation of the trend to reduce coverage of basic computer literacy skills and increase coverage of profession-specific content such as curricular integration. In addition, we are still concerned with the common criticism of PSI that it encourages memorization and discourages higher level cognitive processes. We think that criticism is valid, not as a fundamental or theoretical matter but as a practical matter. It is simply much easier, when time is short, and the beginning of the semester cannot be postponed, to create and use tests that measure facts. We have made some progress toward evaluating procedural and conditional knowledge by requiring students to demonstrate mastery by completing projects and complex assignments, but much more needs to be done. For example, instead of, or in addition to, requiring students to write an evaluation of a lesson plan in the subject area they plan to teach, we need to involve students in developing and microteaching a lesson plan. Such an activity gets at the heart of the profession of teaching, but it is difficult to schedule such activities for 200 students. That task, finding efficient but effective instructional experiences that help students develop some of the professional skills they need in the classroom, is one of the directions we hope to take in future versions of this course.

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INSTRUCTIONAL DESIGN

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In the early days of educational computing, the focus was on the machines and associated software. The discussions often centered around the relative merits of North Star disk drives versus Processor Technology drives, the amount of educational software available for TRS-80 Model I machines versus the amount available for the Commodore PET. Although similar discussions still occur around the technological campfires of computer using educators there have been some dramatic changes in the field since those early days. Educational computing, and specialty fields like technology and teacher education, are not so isolated today. Educational computing sprang up like a weed in the orderly garden of education, and it grew like a weed—quickly, without much cultivation, and outside the garden's long, straight rows.

There is something to be said for innovations that grow up outside the mainstream of a field. The lack of well worn paths and tried and true principles sometimes leads to discoveries that benefit us all. However, as innovations mature they often profit from association with and integration into the ongoing scholarship from other fields. The papers in this section represent some of the efforts to connect our field, technology and teacher education, with other fields of practice and scholarship.

Some of the papers in this section focus on specific issues and specific topics or approaches. The paper by Al-Sharan, for example, relates ergonomics to the design of AV and educational computing spaces. One of the papers by Cafolla and Kauffman argues that Microsoft's Visual BASIC is both a blast from the past and a look into the future because it uses familiar commands but is an object oriented programming environment that facilitates the creation of Windows programs. Another paper, by Jerry Galloway, presents some research on the use of analogies in instruction about educational computing.

Four papers focus on what can be done in a particular type of teacher education course or experience. Merideth and Lotfipour's paper describes a way to support teaching about the concept attainment model in a methods course using a HyperCard stack. Their work illustrates one of the ways technology can support methods courses.The paper by Talab, Bogart, and Hawk, describes an innovative approach to meeting some of the needs of both local school districts and teacher education students at a university. Then Connell describes his work in a graduate instructional design course that covers cognitive instructional strategies. Connell shows that by bringing technology into the course, in this case Toolbook, students developed a more sophisticated understanding of the strategies covered.

On a more global level Norton carefully analyzes the efforts of a large university's college of education to integrate educational computing into the teacher education program. Norton's thoughtful analysis creates a

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broader, longer-term view of the process of integrating technology into colleges of education.

The final papers in this section address the general implications of work in other fields. Schulz, for example, discusses ways to adapt educational software uses in the classroom to students with different learning styles. Tellez relates philosophical and research design issues that surround the qualitative/quantitative dichotomy to research on technology and teacher education, Two papers relate aspects of the broader fields of instructional technology and cognitive science to work in this field. Persichitte presents an overview of the general principles of instructional technology and the Cafolla and Kauffman paper proposes cognitive science as a new foundation for teaching and teacher education.

All the papers in this section point to connections, directions, and perspectives that link the specialized field of technology and teacher education to work in other disciplines related to both education in general and teacher education in particular.

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Physical environment needs for implementing audio-visual technology

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The physical environment should support, enhance and facilitate the implementation of a variety of methods of teaching and learning using audio-visual technology. All teachers prefer surroundings that enable them to get services when needed with a minimum of delay and an environment with convenient access to teaching and learning materials including AV and computer equipment.

Desirable teaching and learning environments are rarely the result of haphazard design and planning. Teaching and learning space should be well designed and carefully planned. Much of the input for the planning process should come from the people who use and work in the space: teachers and pupils, school administrators, media programme director, supervisor, co-ordinator, media specialist, makers and producers of audio-visual material and equipment, consulting engineers, and skilled architects (McVey, 1975, p.59).

The Physical Environment

The physical environment should support, enhance and facilitate the implementation of a variety of methods of teaching and learning using audio-visual technology. Effective application of new teaching and learning methods requires many types of inter-related spaces. Gerlack and Ely (1980) have identified three different spaces as follows:

1. Large group spaces.
2. Small group spaces.
3. Independent-study spaces.

With regard to the teaching and learning spaces Cacilia (1986) suggests more spacious rooms with movable furniture, lighting controls, projection screens and equipment and loudspeaker equipment. In such a space there would be no fixed chairs or dimensions. Instead, the room size would be determined by the size of the group and the type of instruction. There are some guidelines written by McVey (1975) as follows:

For multimedia lectures hall	125 sq ft/persons.
For conference room	20 sq ft/persons.
For flexible classroom	25 sq ft/persons.
For AV/TV carrel	18 sq ft/persons.
For CAI centers/labs	10 - 12 sq ft/persons.

The establishment of audio-visual classrooms requires several considerations including ventilation, lighting and the installation of equipment. Certainly, this suggests that the comprehensive planning and designing of new school building must actively involve the audio-visual programme director. Chapman (1985) points out that the grounds, building and equipment form part of the learning experience and the total school environment must be an invitation to the pupils:

> "to test and develop their powers to explore and discover, to construct, and to express themselves" (p.104).

The school setting should present a large, appealing, varied and irresistible learning situation "so that any child would want to go to school" (Chapman, 1985). Actually, the physical environment of audio-visual technology should be planned at the earliest consideration.

According to Cacilia (1986) in designing the school's IMC (or audio-visual aids centre) there should be enough space available to:

1. Store media equipment.
2. Store media materials.
3. Store audio-visual supplies.
4. Handle the flow of media materials and equipment in and out of the centre.
5. Inspect and clean returned materials and equipment.
6. Handle and process pre-use examinations of media materials by teacher.
7. Prepare special audio-visual media materials for teaching purposes, i.e., a workshop for production.
8. Administer the service programme.
9. Provide and manage the use of fixed technical installations for the schools, such as language laboratories and TV studies.
10. Produce photographs.
11. Produce graphic art.

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Visual BASIC: A new tool for teachers

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For years, those of us using IBM PCs (PC's) and compatibles looked with some envy at our colleagues using Macintosh computers. While we had to memorize cryptic commands to operate our computers, our counterparts were pointing their mouses, selecting items from pull -down menus, and pressing buttons. If that weren't bad enough, Macintosh users could also learn new programs more easily. The user interface was so similar from application to application that the learning curve was dramatically reduced when learning new applications. The Macintosh also made it easy to copy and paste information between applications.

Since the introduction of Windows versions 3.0 and 3.1, PC users have come to appreciate the advantages of the Macintosh approach to using a computer. Windows, like the Macintosh, provides users with what is generally referred to as a graphical user interface (GUI or "gooey"). Because of Windows, many PC users now come to expect point and click mouse operations, standard menus, and the other features of this interface.

Until recently, a major problem with a graphical user interface was the difficulty of writing of programs using the features of the windows interface. When using traditional languages like C, writing programs that could detect a mouse click, draw a menu, or create a button was beyond the ability of all but the most serious programmer. Computer literate college professors who were not computer scientists were accustomed to writing their own simple programs in a language like BASIC. Because of the complexity of writing GUI programs, these faculty generally do not write programs for a graphical interface. Now, thanks to the introduction of Visual BASIC, this situation has changed. Visual BASIC is a programming environment developed by MicroSoft that combines the simplicity of BASIC with the tools to program sophisticated Windows -based applications (Hergert, 1991).

Visual BASIC is a tool that allows you to create applications that use all of the advanced features we have quickly come to expect in a windows based program. Despite this power, it easy to use. Teacher educators who are knowledgeable about computers will be interested in Visual BASIC from two distinct perspectives. First, as an application development tool, teacher educators will use Visual BASIC to develop their own sophisticated Windows based applications. These applications might include computer assisted instructional (CAI) programs, simulations, multimedia presentations, and other types of programs. Second, teacher educators working in the computer science or computer programming area will appreciate the possibility of using Visual BASIC as a programming language for students. Visual BASIC contains many features that make it a reasonable choice for use at the secondary level. This paper discusses Visual BASIC from both perspectives.

Visual BASIC: A Windows Application Development Tool

Visual BASIC allows for the design of applications that include elements that are integral parts of a graphical user interface. These include pull -down menus, dialog boxes, icons, and mouse controls (Craig, 1991). Applications are built directly on the screen by clicking and dragging icons. When you start Visual BASIC, you are presented with a screen like the one in Figure 1.

The major portion of the center of the screen, shown in Figure 1 as Form1 is what Visual BASIC refers to as a form. Forms are the windows that Visual BASIC uses to display information. Once these windows are created, they already have the ability to be sized, minimized, moved around the screen, and so forth. You assign this form certain properties by using the mouse to choose them from the properties bar, shown in Figure 1 directly above the form. These properties control how the form looks and works. Some of the properties include the forms name, size, background and foreground colors and other attributes.

Like other windows, forms can contain many different kinds of information including graphics, text, buttons, and other visual representations. For example, to add a graphic to a form, you simply click on the picture icon in the toolbox shown on the left hand side of Figure 1. The picture icon is located at the top right of the toolbox. Once selected, you place and size the graphic area on the form. Graphics may be added to the window by loading them from disk, or by cutting and pasting from a paint program. Text windows can be created just as easily. Text windows can have attributes like scroll bars, cut and paste capability, and other features assigned by selecting them from the toolbox.

To place a button on a form, you just select the button tool (third button on the right of the toolbox in Figure 1) with your mouse, position it on the form, and decide what type of event, typically a mouse click, the button responds to. Once this is done, you must determine what the button does in response to the message. This is where computer code is written. Using other programming tools to create Windows applications, you must learn a new programming language. But with Visual BASIC, this code is written in the BASIC language many teacher educators already know. Because BASIC has been used widely in education since the earliest microcomputers, many teacher educators are already familiar with this language. Therefore, one can begin to design applications almost immediately.

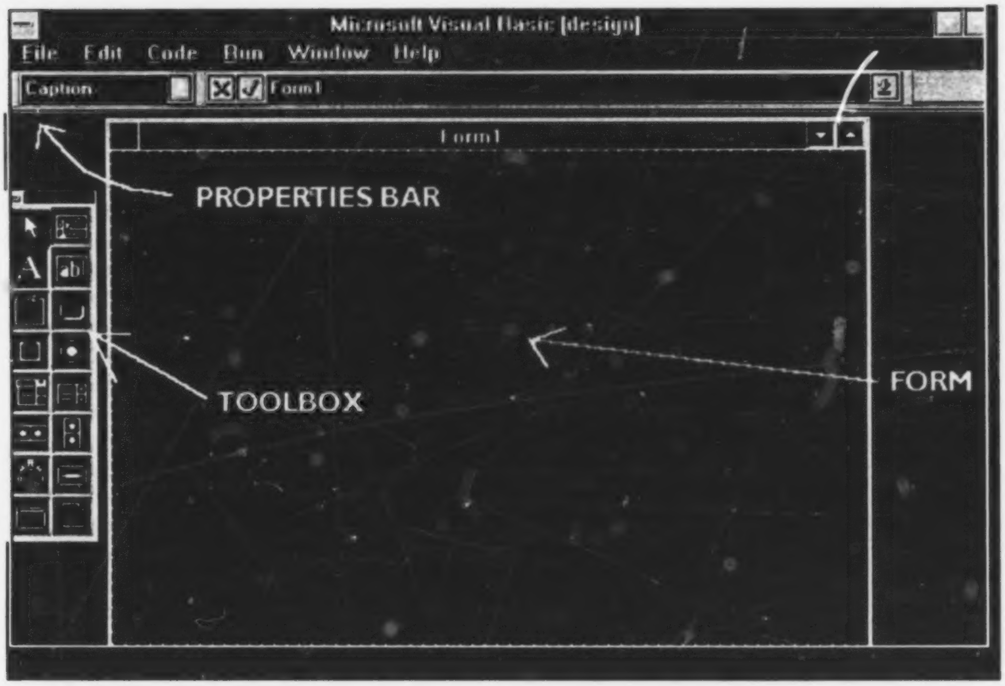

Figure 1. Opening screen of Visual BASIC.1

Visual BASIC: A Programming Language

Teacher educators in the field of computer science education will also be interested in the possibility of teaching Visual BASIC to students. The BASIC language has been taught in schools for many years. This practice has not been without its critics, with most computer scientists believing that BASIC should not be taught at all. Below is a brief overview of the history of the BASIC language followed by a discussion of the differences between older versions of BASIC and Visual BASIC.

The Background of the BASIC Language

The BASIC programming language was developed at Dartmouth College in 1963 by John Kemeny and Thomas Kurtz. Their purpose was to teach college students who were not computer science majors how computers worked. To accomplish this, they made the language as easy to learn as they could. In fact, the first version of BASIC consisted of about seven commands. While the language was concise and easy to use, it was quite limited. Because the language was designed as a teaching tool, not as a full -blown programming language, this was/is not surprising.

If not for the microcomputer revolution, BASIC would certainly have been nothing more that a footnote in the history of computer languages. However, when the microcomputer was introduced in the late 1970's, it came bundled with a somewhat more sophisticated version of the language. These versions, including Apple BASIC, were still quite limited and not really suitable for large applications. Many were written by Bill Gates and his colleagues at a small software company named Microsoft. However, one must remember that these early microcomputer versions of BASIC were written for microcomputers that sported a full 16K of memory!

Schools began teaching computer programming using the BASIC language almost immediately. The reason was simple, BASIC came free with the computer. Early adopters of microcomputer technology were visionaries who saw the value of computers in education, but had not yet figured out how to integrate them into the curriculum. Computers were often purchased with little thought as to how they would be used. Many schools purchased computers but failed to buy software. Therefore, early computer teachers often taught BASIC simply because it was there. This was not exactly the most sound pedagogical reasoning. Nevertheless, BASIC became an important language for teaching students.

In 1980, IBM entered the microcomputer world with the introduction of the IBM -PC. This computer came with a full 128K of memory and a customized version of Microsoft BASIC, which immediately became the industry standard. While this was a relatively powerful implementation of BASIC, there were some significant problems in using it to develop serious applications.

In fact, computer scientists had always had major problems with the BASIC language. They pointed out that BASIC, with its quaint line numbers and virtually limitless ability to GOTO anywhere in the program at any time, was unsuitable for solving complex problems. They noted that trying to follow the code in a BASIC program was like trying to unravel a bowl of spaghetti. This made for poor program readability and made it difficult to maintain and revise a program. Also, since BASIC was an interpreted language rather that a compiled one, it ran too slowly for large, complex applications. Despite these objections, microcomputer users found BASIC to be a useful tool and thousands, probably millions, of educational, business, and recreational programs were written in it

In 1982, Microsoft introduced a radically different implementation of BASIC called QuickBASIC. This product legitimized BASIC as a serious, powerful programming tool. QuickBASIC combined the friendliness and ease of the interactive interpreter with the speed and power of a compiler. Line numbers were no longer necessary, and features of more modern languages like Pascal and C were incorporated. As a subset of the QuickBASIC computer programming language, Visual BASIC has many features that make it a good choice as a programming language for students.

Teaching Visual BASIC

Visual BASIC is a good choice as a programming language for use in secondary education for two reasons. First, as a dialect of the BASIC language, Visual BASIC is easy to learn and use. Second, Visual BASIC uses the latest techniques and theories of computer programming, object oriented programming. This section discusses both aspects of Visual BASIC.

A programming language selected for use in education secondary schools should have features that support an approach to problem solving that stresses reducing the complexity of a problem by breaking it into a series of smaller sub-problems. This powerful problem solving technique is called problem decomposition. Once the subproblems are identified, each is worked on and perfected separately using a process called step wise refinement. This approach stresses a top -down (from general to specific) method of problem solving.

Languages that support this approach to problems are generally called structured languages. Structured languages support the creation of separate modules with their own variables. These modules are used to represent the sub -problems described above. To be useful, these modules must have the ability to receive values (parameters) passed to them. Structured languages also must provide for use of block control statements. These characteristics of structured languages support the valuable problem solving skills of analysis and refinement mentioned above. Visual BASIC is a good choice as a teaching language because, among other things, it provides most of these features.

Visual BASIC encourages the development of separate modules by allowing named subroutines, parameter passing, and user defined functions. As a result, Visual BASIC rivals such structured languages as Pascal and C. Of course, it should be recognized that each language has its own strengths and limitations. Pascal and C have several advantages over Visual BASIC for some applications. However, Visual BASIC makes developing powerful Windows based programs much easier. Since graphical user interface based programs are the wave of the future, students should learn how they are created.

Visual BASIC also encourages modular programming by supporting the use of local variables. All variable are automatically considered local to the module in which they are declared. To create a global variable, you must specifically declare it in a special global module. This is the only way to make a variable available to the entire program. This encourages students to think about each module separately as they improve it. This supports the process of step-wise refinement discussed above. Of course, because Visual BASIC uses a visual approach, programming in Visual BASIC is very different from QuickBASIC. One of the main differences is that Visual BASIC uses an object oriented approach.

Visual BASIC: An Object Oriented Language

One of the most contemporary approaches to teaching computer programming is called object oriented programming (OOPS). In this approach, you create software objects that have certain properties (attributes) and problem solving techniques (methods) that determine how they perform the designed task. These objects wait to be sent a message that tells them when to perform their function. The function the object performs is determined by the computer code associated with it. Visual BASIC uses this object oriented approach to computer programming.

When you create a form, button, graphics window, text window, or other object, you assign it properties (attributes) and describe, in computer code, how it works (methods).

Visual BASIC, like other object oriented environments, creates applications that are event driven. This means that each object in the application responds to specific events such as a key press or mouse click. To show how event programming is different from that of traditional programming consider a simple problem. The problem is to write a program that prints your name on the screen five times. The code for QuickBASIC, is:

```
for index = 1 to 5
 print "Ray and Dan"
next index
```

This code is always executed when the program is run. That is, the program controls when things are done. In an event driven program, the user decides when code is executed. This is usually is done by selecting a button with a mouse and clicking. To create a program that solves the same problem with Visual BASIC, you create a button by selecting it from the toolbox. After placing the button on the form and sizing it, you then change the caption attribute, perhaps to "Print Name," by using the properties bar. Of course, at this point you could also change any of the button's attributes. Next, to add the computer code, you double click on the newly created button. This places you in an editor that displays:

```
Sub Form_Click(1)

End Sub
```

Notice that the first line of the procedure tells the type of event. In this case, a button click on the form, will activate the code you will enter. After the first line of the procedure, type in the same code used in the QuickBASIC example such that it becomes:

```
Sub Form_Click(1)
for index = 1 to 5
 print "Ray and Dan"
next index
End Sub
```

When the program is executed, the button "Print Name" is displayed. However, the code associated with it is not executed until the button is pressed. Code that is executed only when a certain event comes to pass is an essential ingredient in object oriented programming. While the above is a simple example of what is meant by event driven programming, the concept is important when writing programs for a graphical user interface.

Another advantage of the object oriented approach is the short learning time needed to produce high quality applications. This feature, combined with the simplicity of the BASIC language, make it possible for students to create powerful, professional looking applications. Developing applications like this is far more motivational than developing the simple programs commonly produced in today's programming classes. This is another reason that Visual BASIC is a good choice for educators who teach programming.

Implications for Education

The introduction of HyperCard several years ago showed the educational potential of providing teacher educators with powerful development tools. Many teachers in a variety of disciplines have developed their own HyperCard stacks. Because HyperCard is rich in its ability to display a wide variety of types of information, it is an excellent tool for developing computer assisted instruction. HyperCard has also gained acceptance for use as a programming language for students. Many of the arguments for teaching HyperCard to students are similar to the reasons presented for teaching Visual BASIC.

While Visual BASIC is quite different from HyperCard, both provide the opportunity for non-programmers to create complex applications. Since many teacher educators live in a PC world, Visual BASIC may well have the kind of impact on the PC realm in education that HyperCard did on the Macintosh realm of education.

Visual BASIC: A Postscript

A major problem with the first version of Visual BASIC was that applications ran a bit slowly and did not use computer resources wisely. These problems have largely been eliminated with the introduction of Visual BASIC 2.0 (Bonner, 1992). Version 2.0 also provides additional controls that improve the language.

Another problem with the first version of Visual BASIC was that it required a Windows environment. The problem with a Windows program is that it requires a computer with at least an 80286 microprocessor, substantial memory, and a large capacity disk drive. Many schools have not yet upgraded to this standard. Recently, Microsoft announced a DOS version of Visual BASIC that runs on a regular PC. Both of these improvements are sure to make Visual BASIC more popular.

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The relevance of analogy quality in the classroom

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There has been much literature on analogies in concept development (Brown & Clement, 1989; Grandgenett & Thompson, 1991; Gentner, 1983; Gick & Holyoak, 1980; Sternberg, 1977). Most of the literature seems to focus on discovering or developing the best possible analogy for a given comparison. A good analogy seems to accurately or completely represent critical relationships and concepts while less important attributes are considered irrelevant. Most such literature typically falls short of providing practical information for the average classroom teacher on how to actually use analogies as an instructional tool.

It makes sense that students could benefit from complete and accurate mental models. Some analogies have been reported as highly representative of relationships found in their target domain (Curtis, 1988; Halpern, 1987). While there are a few widely accepted computing analogies commonly accepted, others might be considered extreme, dissimilar or even useless (Figure 1.). It seems appropriate to prefer a perfect analogy, a mental model which perfectly represents the target concept. It has been assumed that a really good analogy would better serve conceptualization.

Analogies have been shown to be effective tools in teaching educational computing (Galloway, 1992a). However, it was also shown that analogies must be fully developed with an examination of the similarities as well as differences. In addition, the limitations of the analogy should also be dealt with to obtain positive results. Not all analogies are equally representative in their comparisons and some may initially seem quite poor - but is this relevant for the classroom teacher? While it seems obvious that a good analogy would be preferred over a poor one, is it really necessary to use only the best analogies in helping students improve their conceptual understanding?

Methodology

A group of 85 educational computing analogies (Galloway, 1992b) were rated by three separate experts: one who is employed as a microcomputer operator and had completed the education computer literacy course, a secondary science teacher who uses microcomputers as a personal/professional management tool and to augment instructional experiences, and a secondary computer science teacher who also teaches adult education courses for the state's Department of Education. There were analogies on everything from fundamental concepts (command, data, file, program, etc.) to software and other elements of computer use (word processor, spreadsheet, input/output, variable, etc.). Analogies were rated on a 5 to 1 scale based on whether they where highly representative of the target domain or were a very poor representation.

Deletion in word proc. ↔ human forgetting.
A command ↔ an alarm clock noise.
A program ↔ wash/rinse cycle on a washing machine.
Computer data ↔ information on an award certificate.
A computer language ↔ the laws of nature.
A command ↔ "close cover before striking" on match book.
Input/Output ↔ sewer drainage.
A computer ↔ partner or a friend.
A variable ↔ clear window in an envelope.

Figure 1. Some analogies rated as poor or low quality comparisons.

The 16 "best" analogies and 16 "worst" analogies were selected on the basis of that rating and were then used separately in the instruction of two groups of beginning computing students (11 subjects per group). While the two groups were available because of their enrollment in the computer literacy course, this treatment was randomly assigned to the two groups. Group A received exposure to the best analogies and group B to the worst or poorest of the analogies.

Both groups were taught by the same instructor, with the same content sequence and the same performance expectations. The analogies were spread out across the course to coincide with instructional units and related activities within the course (word processing, BASIC programming, graphics, database, spreadsheet, etc.). Analogies were well developed to include a discussion of both similarities and differences between the comparison and target domains. Students participated directly in the discussions as the analogical comparisons were explored and analyzed.

Data was collected through a pre/post multiple choice test on computing concepts (45 questions). Also, over the semester students wrote detailed essay answers to five questions in a personal journal. In each case, students were told that their task was to create an answer that would help the reader reach a complete and accurate understanding. Essay responses were blind scored with group assignments hidden from the reviewer.

Finally, the end of course exam was included. It served as a measure of overall computer literacy including both knowledge of skills and procedures and conceptual understanding.

Results

While pretest data confirmed an extremely high degree of beginning similarity between the two groups, posttest data show that the two groups remained nearly identical at the end of the course. Table 1 shows that the scores after the differing treatments with analogies were practically identical. The mean scores for the course's final exam were in fact identical for the two groups.

The journal essay responses also showed no significant difference between groups. Each measure, the pre/posttest, the course final, the essay responses on three separate criterion, all indicate that the two groups continued throughout the course to be virtually identical. Results seem to indicate that there is no difference between a good analogy or bad analogy in terms of facilitating students' conceptual development and improving of their understanding. Through proper development and student involvement in analyzing both similarities and differences, both good and bad analogies can apparently be equally effective in helping students improve their understandings in educational computing.

Discussion

How important is the quality of analogies in the classroom? Ritualistic or procedural learning is broadened or enhanced by the development of a more complete conceptual base. However, higher-order thinking and problem solving skills require a level of understanding beyond simple ritual knowledge (Vockell & van Deusen, 1989). Classroom teachers need effective strategies for helping students achieve better understandings. Kintsch and Greeno (1985) support the relationship between understanding and problem solving ability with arithmetic word problems and the need for an internalized "conceptual representation upon which problem-solving processes can operate" (p. 110). The importance of sound conceptual models in problem-solving and higher-order thinking is further supported by Mayer (1989).

While it may be true that "Computing teachers need models for what analogies to use as well as for how and when to use them," (Bright, 1989, p. 5), perhaps the most

Table 1
Post treatment scores and differences

	Good Analogies Group A	Poor Analogies Group B	Differences
Written test			
Percent	65.66	67.27	1.62
Mean	29.55	30.27	0.73
SD	3.09	3.93	0.84
Course Final			
Exam	79.00%	79.00%	0
Journal Essays			
Overall	31.18	30.45	0.73

important focus should be on how analogies can be used most effectively rather than on building a repertoire of good analogies.

All data collected in this study, the written test scores, the course final exam and of course the journal essays, show that the two groups remained similar in spite of the dichotomized treatment of analogies in instruction. The students' achievement in the course, their conceptual development and their ability to use analogies (without being prompting to do so) and explain computing were all apparently affected equally by both good and poor analogies. These results assume of course that analogies are properly developed.

In trying to understand new ideas, students can benefit from an analysis of a concept's attributes, necessary and coincidental, and in seeing how that concept relates to other similar ideas or situations. This examination of relationships, making comparisons and searching through information, is described as "the core of analytical reasoning," (Whimbey & Lochhead, 1984, p. 19). This approach is critical in the proper use of analogies.

There is evidence that analogies can be effective learning tools (Galloway, 1992a). However, as demonstrated in this study, the primary issue, contrary to the concerns of many educators, may not be whether the analogy is good or bad. This author has experienced many cases where educators expressed an immediate negative reaction to some analogies, but usually with little thought given to the details of the comparison. Such labeling may be inappropriate as analogies are selected for use in the classroom. The learning process seems to lie in analyzing relationships and attributes between the target and comparison domains. Analogies may be considered useful so long as they facilitate that process and it seems that so-called good and bad analogies can both serve that process equally - if used properly in the classroom.

Although there are alternative explanations of the results of this study (e.g., the dependent measures were not sensitive enough to detect real differences; the course was so effective, or ineffective, that differences were "washed out"), the fact that multiple measures produced no differences that even approached significance suggests the quality of analogies may not be as important as other factors. Future research needs to focus on classroom instructional implementation of analogies. More work needs to be done to help teachers learn how to use analogies in instruction with students in the classroom rather than on discovering the best analogy or on how to construct the best possible analogy.

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Making *Connections*: Integrating technology with the concept attainment instructional model

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Concept Learning and Technology

The sight of brave, dusty horse handlers herding a rampaging herd of wild horses is a familiar one to veterans of Western adventure movies. Success in this endeavor depended on "corralling" unruly animals in a penned area or box canyon where they were sorted and classified, tamed and trained. Learning new concepts, especially complex ones, is its own kind of adventure—complete with stray thoughts, unruly reactions, and rampaging doubts as students of every level struggle to make connections and meaning. According to Wittrock's (1986) model of generative learning, "corralling" or comprehending any concept is "the generation of a structural or conceptually ordered representation of the relations among the parts of the information to be learned, and between this information or these ideas and one's knowledge base and experience" (p. 308). Mayer (1984) maintains that this type of building internal connections can be increased by explicit training in encoding strategies. For brave, dusty teachers trying to encourage learning, this means that they must lead (and sometimes push and pull) students to form cognitive connections or relations between elements of new information and what they already know.

The technical problems of teaching for learning for today's teachers are exacerbated by the learning attitudes of their students. Moeschl and Costello (1988) report that "teachers are facing an increasing number of learners who do not respond well to traditional teaching methodology" (p. 77). These students are bombarded by a world rich in visual images, exploding information, and demands on time. It simply is not possible to remember everything. Effective teachers, then, are selective teachers: they select key concepts and organize them to increase meaning and comprehension for students (Prawat, 1989). Effective teachers are also innovative teachers who go beyond the traditional methods (lecture, class discussion) to present a concept and its organization.

This paper reviews a nontraditional model of learning concepts—Concept Attainment—with a nontraditional way of presenting the model—HyperCard technology through the *Connections* program—as an approach to effective learning and teaching. Both contributors to this approach, the model and the technology, are concerned with efficiency. In his early work on thinking and concept attainment, Bruner (1967) found that, "the establishment of a category based on a set of defining attributes reduces the necessity of constant learning" (p. 12). Understanding the defining attributes allows the learner to efficiently place the new information into a category thereby learning in less time with fewer errors. A teacher/educator can use the HyperCard *Connections* to stimulate and maintain student attention while presenting the defining attributes of a concept more efficiently than writing examples and nonexamples on a blackboard or overhead. The program contains set fields for prior entry of information and blank fields for students' contributions so that both prepared categories and spontaneous contributions can be accommodated. Furthermore, all this information can be given and received from a position facing the class so that attention is not disrupted and student responses are not missed.

Steps of the Concept Attainment Model

The Concept Attainment Model for instruction begins with the teacher selecting a concept to be learned and listing exemplars of the attribute and nonexemplars in pairs in "Yes" and "No" columns. For example, if the concept to be attained is "nouns," a partial list could consist of the following pairs:

Yes	**No**
eagle	swimming
shirt	tremendous
child	leads
New York	hardly

Exemplars and nonexemplars are uncovered or given in pairs so that students can compare and contrast the attributes of the pair. The positive exemplars all share the attribute in common. The negative exemplars do not necessarily share anything in common: they are simply nonexamples of the attribute. In this way, students not only learn what a concept is; they learn what it is not. A complex concept may need up to 20 pairs of exemplars and nonexemplars for students to form a correct hypothesis of the concept, but simpler concepts can be identified in 10 or less. All student ideas are accepted and recorded, then eliminated or accepted and refined by further examples of the concept.

In the next step, students examine all the attributes to form a definition of the concept and compare it to the "text" definition. More exemplars and nonexemplars are offered by students to test comprehension. The final step of the model finds students taking control of their thinking strategies by analyzing their thinking during the process, evaluating the role of hypotheses, and considering the number and type of hypotheses.

The Concept Attainment Model presented with technology can be used at any grade level for any subject, any concept. It does not require a change in the curricular concepts taught, but rather a change in the way those concepts are taught. Cognitive developmental levels are important, however, when designing the lists of attributes. It is quite possible to use Concept Attainment with lower elementary children, but the exemplars would have to focus on concrete items for which young children would have a reference (for example, television, not cathode ray tube).

Table 1
Summary of the Concept Attainment Model

Model Process	Model Syntax	Teacher's Role	Students' Role
Step I	• Present exemplars and nonexemplars. • Form hypothesis and definition	• Present labeled pairs of exemplar/ nonexemplar	• Compare and contrast all examples • Generate and test hypotheses • Formulate a definition
Step II	• Test hypotheses • Students generate more exemplars and nonexemplars	• Confirm hypothesis • Name concept and elaborate	• Generate additional exemplars and nonexemplars
Step III	• Process thinking strategies	• Guide discussion	• Describe thought during the process • Discuss various hypotheses & attributes • Discuss types of hypotheses

(Adapted from Joyce, Weil, & Shower, 1992, p. 153)

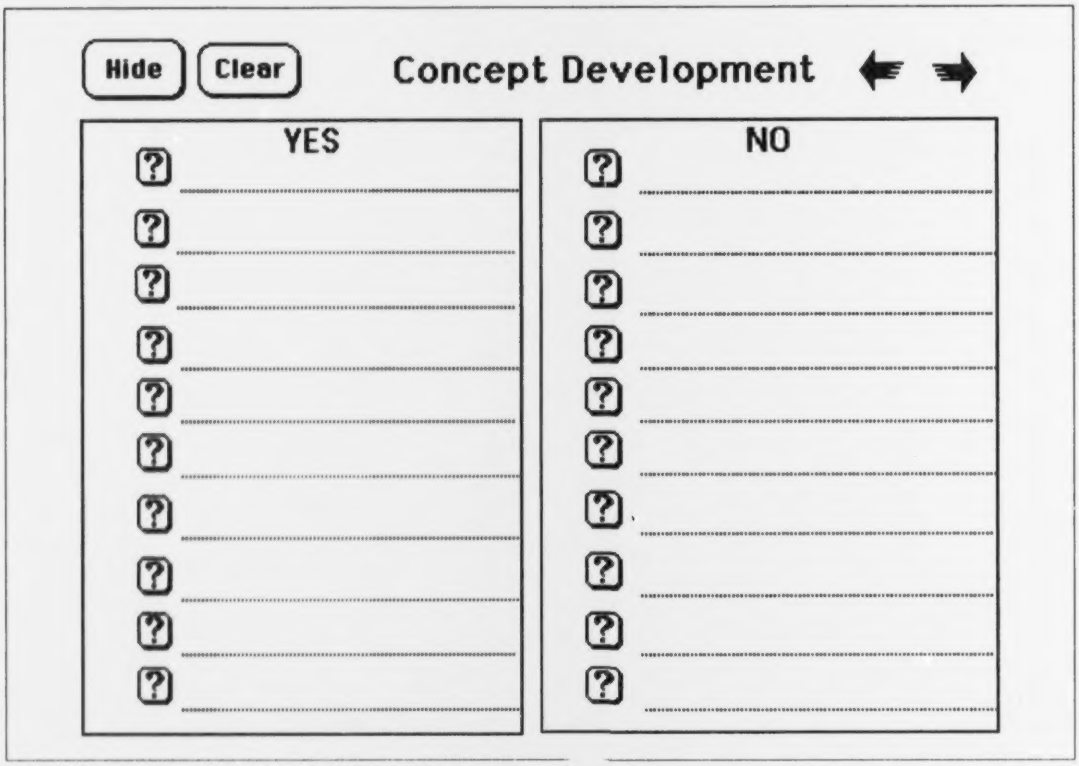

Figure 1. Attribution Card(s)

Connections HyperCard Stack

The HyperCard program, *Connections*, while designed to present all stages of the model, is best suited to concepts whose attributes can be described with words, short phrases, or numbers. The attribution fields, however, can be adjusted to accommodate sentences with a word or phrase presented in "bold" type or "italicized" for clarity. Graphic symbols, other symbols, even scanned images could be used within this program to "fill" the fields and provide exemplars and nonexemplars. (See Figure 1.)

Once the fields have been filled, they can be hidden by clicking on the "Hide" button. Subsequent clicking on the "?" buttons reveal the fields one at a time. The directional arrows in the upper right of the card allows movement within the program so that hypotheses can be recorded and fields reviewed. Once the concept has been correctly identified, the students are presented with a card with open fields to register student-generated examples and nonexamples of the concept. The last card of the stack facilitates the metacognitive strategy of the model. When the steps of the Concept Attainment Model have been completed, the program can be cleared selectively and saved to be used again or cleared completely by clicking the "Clear" buttons on each card.

Types of Attributes

The following attributes used within the fields of the HyperCard program, *Connections*, serve specific functions in defining or clarifying concepts:

- *Essential Attribute*—characteristics that identify an item as part of a category. For example, an orange must have characteristics of the class or category of a citrus fruit to be identified as a piece of citrus fruit.
- *Positive Exemplar*—an example that contains all of the essential or critical attributes of a category.
- *Negative Exemplar*—an example that has the absence of one or more of the essential or critical attributes of a category.
- *Multiple or Variable Exemplar*—an example that requires the presence of several attributes to be classified within a category. A "green-eyed girl," for instance, requires green eyes and femaleness to be a positive exemplar.
- *Concept Definition*—a statement that outlines the essential attributes of a concept. The concept defini-

tion of "herb"—a plant that has a fleshy stem as distinguished from the woody tissue of shrubs and trees, used in medicine or as seasoning, and that generally dies back at the end of each growing season—states this category's essential elements. Positive examplars would be parsley, sage, and thyme. Negative exemplars would be nutmeg, cinnamon, pepper, salt.

Applied Research Results

Research about the effectiveness of integrating technology with the Concept Attainment Model has been conducted at the university level in a Drake University teacher education class and in a secondary language arts classroom. The preliminary pilot at the university level found students generally enthusiastic about the program and able to finally define to their satisfaction the semantically confusing concept of "negative reinforcement." For easy viewing with an LCD screen, this work established the need for a font size of at least 14 points with a bold style (Chicago, for example). Students found the method useful both for group learning about reinforcement strategies and individual tasks such as setting up spelling programs or math reviews.

Research at the secondary school level involved using the HyperCard program, *Connections*, to review/teach the eight basic parts of speech over an eight-week period. The sample populations contributing data were a Sophomore language arts experimental group (n=26) and a Sophomore language arts control group (n=25). Technology was a part of both groups: the control group worked on the eight basic parts of speech with traditional grammar exercises presented with a Macintosh computer and LCD, while the experimental group studied the eight basic parts of speech through the *Connections* HyperCard program presented with an LCD. Scores indicate statistically significant learning from both groups ($p<.001$). The experimental group, however, showed a greater gain between pretest and posttest, reflected in a higher posttest score despite a lower pretest score, a larger T ratio, and a higher Pearson R (See Table 2). An independent t test did not confirm statistically significant differences between the groups perhaps because of the impressive growth of both groups.

Beyond the cognitive achievement of the students, an attitude survey was distributed to the experimental group both before and after the treatment asking students about their reactions to learning grammar in general and learning with computer-assisted instruction in particular. Some items (9, 10, 17, & 18) were structured negatively to check for response set and random responding. For these items, growth would be measured in a lower second score instead of a higher second score. Table 3 lists the items and means of the two attitude surveys on a Likert scale of 1-5 where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree.

In this survey, students' confidence in their abilities to identify, understand, and give examples of the eight basic parts of speech has been enhanced considerably through the use of the CBI program, *Connections*. They still don't like to study grammar, but they indicate that they are less intimidated by it. Mrs. Hope Bossard, their teacher, confirmed that by using *Connections* to develop their own definitions and examples, students clarified previous "fussy" notions about adverbs, conjunctions, prepositions, etc. By inductively developing their own definitions, students take ownership both of the concept and their own learning. With self-confidence in their ability to handle the concepts of basic grammar, these same students also report a greater recognition of the necessity of learning the eight basic parts of speech and grammar's contribution to good writing.

The general positive reaction to the Concept Attainment approach to teaching grammar is reinforced by students' replies about the use of the computer. After the study, the students register gains in the first six categories that ask about the effectiveness of teaching and learning with a computer. Students feel that they like a teacher to teach with a computer, that class is more interesting, that they learn better, and that they learn more when CBI is used. Their teacher supports their view by indicating that the computer has saved time with this model even as it encourages time on task.

Table 2
Test for Dependent Samples

Group	*n*	Pretest Mean	Posttest Mean	T Ratio	Pearson R	*p*
Exper.	26	12.615	24.154	-10.029	.616	<.001
Control	25	12.842	24.000	-7.819	.567	<.001

Table 3
Attitude Survey A and Attitude Survey B

Grammar Items	Survey A	Survey B
1. Learning the 8 basic parts of speech is necessary	3.64	3.84
2. Knowing the 8 basic parts of speech is necessary for good writing	3.88	4.08
3. Learning the 8 basic parts of speech is boring.	3.52	3.56
4. I can identify the 8 basic parts of speech in a sentence.	2.44	3.64
5. I understand the concepts of each of the 8 basic parts of speech.	2.72	3.68
6. I can give an example of each of the 8 basic parts of speech.	2.36	3.52
7. Learning the 8 basic parts of speech is difficult for me.	2.92	3.2
8. I look forward to the grammar unit(s) taught in my English classes each year.	1.84	2.2
9. I feel intimidated by traditional grammar exercises.	2.68	2.6
10. Grammar confuses me.	3.08	3.08

CBIItems	Survey A	Survey B
1. The goals and objectives of teaching grammar can be effectively addresses by using a computer in the classroom.	3.12	3.72
2. I like to use a computer.	3.6	3.88
3. I like a teacher to teach with a computer in front of the class.	2.72	3.52
4. Class is more interesting when a computer is used.	3.04	3.76
5. I learn better when a computer is used.	2.96	3.32
6. I learn more when a computer is used in the classroom.	2.96	3.2
7. I would rather write on the board than use a computer in front of the class.	2.64	2.68
8. I would rather write on an overhead projector than use a computer in front of the class.	2.84	2.56
9. I am more creative when I use a computer versus using a pencil and paper.	3.44	3.04
10. I wish more of my teachers incorporated computers into their classes.	3.2	3.2

Conclusion

When Resnick and Kloperf (1989) report that, "Cognitive scientists share Piaget's constructivist view of learning, asserting that people are not recorders of information but builders of knowledge structures" (2-3), they reflect important changes in learning theory and teaching practice. Establishing the relevance of new information has been considered a motivating method for some time, but relevance can now be appreciated as an integral part of correctly linking new knowledge to past cognitive networks or schema. The Concept Attainment Model allows students to make instruction about specific concepts meaningful even as they model inductive reasoning and become aware of alternative perspectives and their own metacognition. The HyperCard program, *Connections*, complements the goals of the model, for it too models an alternative approach, preserves the inductive structure of the model through preprogramming, and by its varied functions, encourages logical thinking and classification. Concept Attainment and HyperCard technology used together by teacher educators become cognitive connectors for an efficient, nontraditional method of teaching and learning across all curriculums.

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Teacher technology in the clinical setting: The preservice teacher technology assistance program

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The "If" Versus the "So" Paradigm

What if a paraplegic could stand up in a "virtual reality" and hug her parents for the first time? What if a doctor could give a check-up by letting the patient travel through the "innerspace" of his own body? The "If" paradigm—the "big idea . . . lives somewhere in the future. It must be big enough to capture all of your imagination and good enough to satiate you completely if you ever reach it" (Laurel, 1990).

Motivation is a key factor in encouraging entrance into a professional field. Helping students to construct their own "If" paradigms—to see the creativity, ingenuity, and vision of technology in teaching, can motivate them to incorporate this technology more seamlessly into the curriculum. The Rand Corporation's study of innovation in schools found that any innovation in schools will fail if it doesn't take into account the complex social structure of the schools and if it doesn't put the teacher at the "dead center of the loop" (Snyder, as cited in Olds, 1989).

Motivation is the problem in the "So" paradigm. For each person that lifts up her hands and asks "What if?" there is another that puts her hands on her hips and asks "So?" It's not as easy to drag the unwilling forward by his feet as it is to place him in a comfortable armchair with wheels and roll him along. The analogy being that asking teachers to learn technology in their "spare time" or through "captive" in-services is not as productive as providing them willing assistants who value their professional expertise.

Technology Integration

Nearly everyone agrees that teachers need to learn more about technology (Becker, 1990; Higgins, 1991; OTA, 1988; Sheingold, 1991; Wirthlin Group, 1992) and nearly everyone agrees that pre- service teachers need greater technology skills (Applefield & Earle, 1990; Earle, 1992; Branch, Darwazeh & El-Hindi, 1992). Research indicates that pre-service teachers do not feel prepared to teach using technology (Fulton, 1989). Yet the typical Instructional Technology class places all disciplines in the same class, separate from subject content classes, to learn technology, thereby severing that vital link that integrates technology with subject matter.

To get an idea of the needs of teachers in our local school district a "District Technology Survey" was developed by Dr. Tom Hawk and Jim Bogart and administered to all district teachers in early May, 1992. Attesting to the high level of interest in technology integration at such a difficult time of the year, the response rate was 80% with no followups. Typical open-ended answers from teachers to the question, "What training and support do you think you will need in the future to help you utilize technology more effectively" were:

- If it's new and you want me to use it, I need hands-on

practical training—inservice, after school, released time, summer.
- I'll need basic, thorough, and frequent encounters.
- Specific techniques for using courseware in the
- Training time is the key. I feel like I need to take a year's sabbatical to get caught up with the computer age.

Jim Bogart is the only staff person dedicated to technology training in a district with 11 schools in two towns. The district created a new Technology Center in the Fall of 1992, and Jim gives seminars on technology topics in the center, where IBM Ultimedia machines are located, and also gives seminars in the schools.

U.S.D. #383 is considered in the state to be exemplary for its size. A school in this district was selected as one of four examples of "what is right with education" on the McNeil-Lehrer News Report in 1991. The district school library media program was selected by the American Association of School Librarians as the best district program of its size for 1992. (Some years the award is not given.)

While the school district and university have a history of collaboration and partnership in teacher preparation, one inhibiting factor has kept pre-service teacher education from using district services in technology use. U.S.D. #383 uses IBM microcomputers and laptops. The College of Education uses Macintoshes. The College has a networked undergraduate Macintosh laboratory with a multimedia instructor demonstration station and portable multimedia instructor demonstration stations. Currently, five 286 512K Zeniths are being used to teach basic PC operations in the 160-student teacher technology class for the new Elementary Education program that has a one hour field experience component in Math/Science/Technology. Greater efforts are needed to develop more relevant, field-based technology experiences.

Two district-wide initiatives involving master teachers are in place: 1) the Networking Project is in it's second year (13 teachers were added the first year and 13 teachers will be added this year); and 2) the Multimedia Project. In January, '93, district-wide study groups began forming around such topics as gradebooks, for example. Each school has an IBM Ultimedia station and the high school has a Macintosh multimedia station. While there are technical support people, having only one staff person to provide district classes and instructional support makes technology integration complicated.

Course Development

Teachers need technology assistance and pre-service teachers need clinical experience with a master teacher. We decided to develop a course that met both needs. A pilot program for pre- service teachers was developed for this purpose for Spring, 1993, with two components:

1) A teacher technology assistant assignment is available on an independent study basis to students who have completed the introductory technology course, Instructional Media and Technology, and received a "B" or better, or who "quizzed out" of the computer section of the introductory technology course and need an advanced project.

In order to assess needs and make a proper fit between teacher and the technology assistant, prospective students must fill out a survey assessing their production skills, software applications experience, and subject area. Individual teachers meet with the assistants at the beginning of the semester and work out a technology project for the student to assist the teacher with, either as a culminating experience or as a series of "teacher assists" in specific areas that the teacher would like to have help in learning. Depending on the skills or assistance needed by the cooperating teacher, the student will be in the process of creating a technology project early in the semester. Students visit the teachers periodically until their skills and projects have been developed.

2) The division of the undergraduate technology course into Elementary or Secondary project groups for the purpose of working on projects that are directly related to district technology needs and initiatives. For example, one project group might study gradebooks for the district gradebook study group and provide the study group with an evaluation or examples of each program.

Each project group must work on a topic that has been jointly determined by Jim or I (Rosemary Talab) as being useful to practicing teachers. Each group elects a representative and that representative is responsible for reporting to the teacher or study group via e-mail on the technology class group's progress, as well as consulting with the proper person(s) on changes or needs. Software is chosen by the group for evaluation. If one type of software is chosen for an Elementary group, such as a teacher productivity package, then each student develops an activity for that package. At the end of the semester each Elementary teacher education student has the option to purchase a notebook of all Elementary activities produced for the class. Because there are so few Secondary students (30-50 per semester out of 160) they may choose activities and download them from the fileserver.

Teachers and study groups who wish to participate must also fill out a survey assessing their needs and expectations. They are then matched to each other and brought together at the beginning of the semester to meet with the teacher education students who will be working with them. Coordination for this project is shared by the university instructor and the school district technology director. Regular school visitations are made by the university instructor to see how projects are progressing. The district technology director oversees teacher use and troubleshoots technical problems.

Bridging the Technology Gap—For Now

After considering many alternatives: software to emulate a PC, software that allows HyperCard scripting on the PC, etc., the best course of action seemed to be to use HyperCard on the Macs and LinkWay on the five college PC's for any multimedia projects. Jim Bogart generously allows us to use the Ultimedia machines at the district training center for classes, as well. With such a wide subject range and the belief that subject software should be taught in specific methods classes, the emphasis in this project and participating classes is on productivity software exploration, using Teacher Toolkit, desktop publishing programs, etc., which district teachers have shown interest in using or having evaluated.

Evaluation Plan

The state of Kansas has developed Quality Performance Assessment standards. All student learning must be evaluated against measurable behavioral outcomes. All programs must incorporate these desired outcomes into course planning.

The desired outcomes for teachers and teacher assistance students and groups are:

1. cooperatively developed projects
2. used in a lesson or lessons with K-12 students

New Partnerships, New Paradigms

This project promises to provide practical technology experiences for both students and teachers. It does require a rethinking of the customary teacher/pre-service teacher role. The teacher, instead of feeling that he/she must be the authority, must learn to become the "guide on the side" and be comfortable with not knowing everything and being a facilitator for the multimedia learning/teaching experience. With the massive restructuring and redefinition of pre-service education based on more clinical field experiences we believe that all participants benefit.

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Teaching instructional design using technology

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Effective instructional design has long been a problematic area for both teacher candidates and experienced teachers. This is hardly surprising since to design an effective instructional unit requires a deep knowledge of the content area and associated pedagogical content knowledge, appropriate evaluation methods, and how students construct their own understandings of the content area. These prerequisites require the teacher to have much more than a passing familiarity with matters of instruction, epistemology, and evaluation. It is little wonder that for the methods instructor attempting to enable teacher candidates to design effective instruction these problems often seem insurmountable.

The past 10-15 years, however, have seen major advances from a cognitive perspective that offer great insight into some of the learning strategies which are used by successful students. What is particularly helpful for the teacher of instructional design is that many of these strategies are easily implemented using technology - both as a means of investigating the strategy itself and the ramifications it may offer, and to design actual instructional units which are enhanced through the use of technology. Technology in this situation serves not only to teach about the strategy, it becomes a medium through which the strategy is used by the teacher candidates to develop their own lessons and units.

During the 1991-1992 academic year a cooperative masters program was offered by the University of Utah with an emphasis upon technology. As a part of this program the existing instructional design course, Educational Studies 622—Theories of Instruction, was modified by the author to include technology as a formal part of each class session. The course began with an introductory session discussing the role a theory of knowledge plays in designing instruction and introducing the cognitive constructivist perspective.

As a part of this course, a variety of cognitive strategies were modeled by the author—including a technology enhanced version—in their actual instruction. For example, chunking would be used as the primary instructional method during the section on the use of chunking, an advanced organizer to teach advanced organizers, and so on. Following the teachers' experience with reading about the strategy from the text, seeing the strategy modeled in instruction as described above, developing a use for the strategy (although not always possible they were to develop this for a unit they were currently working on with their students), as a concluding activity ToolBook was used to create a technology enhanced version of the strategy for use with their students.

In comparing this version of the course with prior sections taught by the author several interesting features stand out as being worthy of interest. First, the use of technology allowed the teachers to develop a much deeper understanding of the actual strategy itself. This was evidenced by an increased ability to hybridize the strategies into new approaches; a better match between strategy and content; and more consideration of matching the strategy to the needs of students of various abilities and backgrounds, to name only a few. Second, the ToolBooks created by the teachers forced them to put in an external form the result of their internal thinking. These books became objects for discussion, which promoted further reflection upon their utility - both as strategy examples and as units. The teachers found this period of critical reflection to be highly valuable in rethinking their original conceptions and design. Third, the performances of the teachers on the assignments and examinations comprising the course were of higher quality than had been seen in any previous section. This is evidenced by noting that the lowest grade for any student in this section was an A, which had been unheard of in any prior section.

A little theory

For the teacher of instructional design, particularly if this person is technologically literate, the findings of the past 15 years from cognitive science and artificial intelligence assume an additional level of importance. Although these closely aligned fields of science are separate disciplines, both fields clearly owe a great deal to the information processing metaphor. It is no small accident that many of the cognitive strategies identified in the literature (West, Farmer, & Wolff, 1991; Winn, 1991) owe a great deal to the initial thinking of Minsky (1975), Davis (1979), Sternberg (1985), Ortony and Radin (1983), and others. As many of these cognitive strategies possess a significant information processing history, together with an equally impressive use in artificial intelligence, it is interesting to note that they are easily implemented using technology. The use of technology in designing instruction can then be extremely beneficial as research supports the notion that effective learning may be enabled through the very methods of information storage and manipulation strategies information technology does so well.

A brief history

Over the past three years this author has had experience in using technology in two fashions in the course of teaching Educational Studies 622 - Theories of Instruction, a graduate level course in instructional design. The initial use of technology was almost serendipitous. In the course of preparing for the first offering of the course by the author a great deal of material surrounding each of the cognitive strategies covered in one of the texts for the class *Instructional design: Implications from cognitive science* (West, et. al., 1991) was gathered. A ToolBook program was created with chapters for each strategy as a means of organizing this information for later classroom use. This project was originally designed for personal use by the instructor and as an organizational tool only.

During office hours many students in that first quarter had the opportunity to observe the rapid recall of information enabled by the ToolBook program itself. One of the doctoral students made explicit what would be a recurring theme from many of them, "You really are just using a frame of type one (one of the cognitive strategies from the text), aren't you? From the text, I never realized just what this would look like." The author soon realized that by using the technology to embody the strategies being taught students could gain a deep insight into the inner working of the strategies and better understand how they would look and feel to a learner. Using Toolbook also gave students the opportunity to more efficiently use them in their own designs.

The ToolBook's created over the next two years evolved and changed from that early information management system to a series of eight separate (due to the huge amounts of memory each was gobbling up with scanned images, examples, etc.) lessons. The first uses were fairly simplistic and, frankly, decisions were made on the basis of time availability as opposed to pedagogy. Those early lessons were used by the author as a demonstration and presentation medium to illustrate a wide variety of cognitive strategies and their implications. They provided instantiations which went beyond the static illustrations in the text. With a portable computer and a color LCD plate in hand, the author began to take the show on the road.

Such a use, as primitive as it was, began having a powerful impact in the classroom and in the enthusiasm of the students. Although much of those early presentations has been discarded, they still form an important part of the course. The difference between a student who has *seen* a demonstration of a frame becoming dynamically instantiated with background information, who has *constructed* logical links between row and column headings or from cell to cell, and the student who has merely read a text and viewed a chart must be seen to be appreciated. For the first student, the strategy is a dynamic, powerful tool to be used and adapted for their own work; for the second student, the strategy is just another topic to file away in the read, recall, reject cycle which we see far too often in academia.

The second level of use, the design of actual instructional units which are enhanced through the use of technology by the students, is a more recent development. During the 1991-1992 academic year a cooperative masters program was offered by the University of Utah with an emphasis upon technology. Based upon the preliminary success using the earlier presentations the instructional design course was modified for this cohort to include exercises using technology to construct a working computer enhanced lesson incorporating the strategy of the week as a formal part of each class session.

Students were quickly laying out frames of various types, setting up concept maps using a wide variety of support programs, creating visual images representing complex phenomena, and so on. It was quickly found that technology in this situation served not only to enable the student to learn more about the strategy, but rapidly became a medium through which the strategy was used by the teacher candidates to develop their own lessons and units.

The experiences of the author over the past three years have been varied, but several main themes about the use of technology emerge. Beyond question, the use of technology - regardless of the level of sophistication of the program - allowed the teachers to develop a deep understanding of the actual strategies themselves. This understanding allowed the students to better use these learning strategies in the larger problem of designing instruction. Student perceptions of the strategies moved from being static and text based to more dynamic and student centered. These growths are evidenced by a wide variety of measures. Student ability to hybridize the strategies into new approaches - combining advance organizers and concept mapping, for example - has increased consistently over the three year period. Likewise, there is a better match between selection of strategy and content for application; and more consideration of matching the strategy to the needs of students of various abilities and backgrounds, to name only a few.

Secondly, the ToolBooks created by the teachers forced them to put in an external form the result of their internal thinking and planning. It was not possible to shrug off the whys and hows which underlay their selections and decisions. All of these were observable to all and could easily be pointed out for discussion. These books became the objects for discussion in and of themselves. This further promoted student reflection upon their utility - both as examples of the strategy as it would actually be observed in the classroom and as units. The teachers found this period of critical reflection to be highly valuable in rethinking their original conceptions and design. Although the students typically complain initially about the requirement to learn an authoring system at the same time as designing instruction using a new approach and philosophy, by the end of each quarter, to this point at least, there has been unanimous agreement that the effort has been worthwhile. A better solution, although one which is not feasible except in rare instances, is to position this course such that students enter it having had experience in either the authoring system of choice, the cognitive strategies and their use in instructional design, or both.

An example

To see what this approach might look like in the classroom, we will look at an example from the course described above - the use of concept mapping as an instructional design tool. This example is taken from the working paper *External representations of internal structures: Educational implications of concept mapping* by Harnisch, Connell, and Zheng.

In order to discuss the relationship between concept maps and the content structure, we need to look briefly at the basic structures of knowledge. Knowledge can be categorized into three types: declarative, conditional, and procedural. To put it into simple terms, declarative knowledge corresponds to "knowing that"; conditional knowledge corresponds to "knowing when"; and procedural knowledge corresponds to "knowing how". Therefore, when the material to be mapped is declarative in nature, either spider maps or hierarchical maps may be used. If the knowledge is procedural, the relationship will be either timing, causal or enabling and thus chain maps should be used (West et al., 1991). However, we have to remember that these are general suggestions and that we have to choose appropriate types of maps taking into consideration the material to be mapped and the specific context. For example, sequence of time may represent declarative knowledge in the case, say, of chronicle events; it may also represent procedural knowledge such as a series of steps that have to be followed in completing a task. Therefore, a particular type of map is not necessarily reserved for a certain type of knowledge. As the knowledge base consists of combination of different types of knowledge, it is not surprising that many of the concept maps we see are hybrids of different kinds of maps. Nevertheless, these three are the common types and they usually form the cornerstone of more complicated concept maps.

Creating Concept Maps

Before we introduce the general guidelines, we have to point out that these are some "rules of thumb" and suggestions which are not meant to be followed rigidly. In working with your own students you will need to be sensitive to their individual strengths and difficulties.

Reflect on materials and instructional objectives. We mentioned earlier the advantage of using concept maps—it is easier for the learner to grasp major concepts and their relationships, and that the disadvantage is the loss of details. Therefore, if the objective is the mastery of details, concept mapping may not be a wise choice. Prior to constructing a map of a subject area, one should take into consideration such variables as subject matter content and task outcomes.

"Chunk" or organize the material to be mapped. The user has to carefully organize materials based on the reflection of the internal structures of materials to be mapped. A visual representation of this might involve a two-dimensional framework for organizing concepts that vary by teacher emphasis and student's ability to understand. The result of such a display might be something like a visual display of teacher generated important concepts in math on dimensions of emphasis given and student's ease in understanding.

Isolate concepts and determine relationships between or among concepts. This is usually a step of trial and error. The user can write concepts on cards or on anything that can be easily moved around.

Choose appropriate type or types of maps. This decision is usually based upon a careful consideration of the material to be mapped, and the relationship between or among the concepts which have been identified as comprising the key nodes of the completed map.

Link the concepts based on the relationships. Computers can be used to draw the concept maps based on the relationships for the concepts which the user must specify. Application software is available for assisting users in mapping subject matter content on the Macintosh. We use the *Learning Tool* (developed by Robert Kozma, & John Van Roekel, University of Michigan) which allows the user to specify the concept (with definition cards) and interconnected relationships among the concepts with prepositional phrases printed. These application materials are valuable to students as they document the connections among the key concepts for their respective courses. These materials are referred to as an "electronic notebook." They help the students organize their notes and study for exams. Using these tools allows the student to build on their strengths and identify the gaps that all of us have in learning.

Concept Mapping Summary

In summary, research studies have indicated that the concept-mapping procedure is a useful alternative in designing, implementing, and evaluating classroom instruction. It stimulates meaningful learning and helps students internalize specific concepts and integrate them into their knowledge structure. Theoretically this is a preferable teaching mode. The results of a systematic set of research investigations support this approach. Therefore, we feel that classroom teachers should be encouraged to become familiar with and experiment with this powerful visualization tool for professional practice.

Summary

Despite the strange trail followed by the author, the use of technology as a tool for teacher use in designing effective instruction should not be confused with the use of technology to deliver instruction. In addition to being more satisfying to teach, the courses which featured a student centered construction of meaning were much more successful.

Winn (1991) points out that taking a student centered approach to instruction as advocated here requires the ongoing teacher monitoring of student progress across a wide variety of outcomes and subsequent modification of instruction "on the fly" as it were. The author has found that it is very helpful to have mapped out three or four possible passes through the domain in advance, and then select the path which is right for this particular group of students at this particular time. Thus, the design of the instruction itself needs to be fluid and allow for multiple possibilities. Clearly, when viewed in this perspective, technology in instructional design will not replace the teacher, but rather reinforce the central role played by teachers in selecting, guiding, and designing meaningful experiences for their students (Sato, 1991).

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Teachers, technology, transitions: Lessons from ten years of history

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The University and local school district in Albuquerque, New Mexico began collaborating in 1982 to facilitate teacher education that supports the integration of technology in the educational process. Moving from site-based programs to University-based programs, efforts have under gone many permutations. This paper describes these transitions and identifies lessons useful for guiding effective teacher education. Lessons center on the general theme of change supporting the notion that teacher education about technology is of necessity an educational process for and about change.

Historians tell us Gutenberg invented the printing press in 1452. They do not tell us, however, that Gutenberg had any sense that his invention was to bring about "the most radical transformation in the conditions of intellectual life in the history of Western Civilization ... [whose] effects were sooner or later felt in every department of human activity" (Eisenstein, 1979:321). With the advent of the printing press, editors and printers were compelled to standardize texts, reordering their parts, dividing them into coherent sections, and indexing citations. This process made the ancient texts accessible, stylistically intelligible, internally consistent, and easily reproducible. Which is to say, knowledge was reinvented. This led, over time, to habits of knowing that James Joyce mockingly called ABCED-mindedness, meaning a structure of consciousness that closely parallels the structure of type. For the next five hundred years, this structure of consciousness has shaped how we know and, as a consequence, what we know. The format of books made possible by the printing press changed Western civilization from a scribal culture to a print culture. Educational practices changed as a consequence, placing processes for using the technology of the book within its structure.

Historians have not definitively assigned the invention of computers to a particular individual. Neither have they affixed a date to its invention. Yet, someday, someone will write with authority: In the second half of the 20th century, a disparate collection of scientists, mathematicians, and engineers brought together a cluster of concepts and instantiated them in silicon and plastic. A group of enterprising entrepreneurs made this invention readily accessible, changing a print culture into a computational culture.

Change is once again upon us. To say that American society is moving from an industrial to an information society or to chronicle speculations about the nature of such a society would be tautologous. In fact, to refer to contemporary American society as an "information society" has become a cliché obscuring much of its significance as a consequence. Nevertheless, few would deny that as the traditional configurations of society alter their form, all social institutions are being profoundly affected—education as deeply as others.

In 1970, Alvin Toffler wrote that technology is the engine of change, stating " this is not to say that technology is the only source of change in society ... Yet technology is indisputably a major force behind the accelerative thrust. (p. 25)" He further wrote, "technological innovation consists of three stages, linked together into a self-reinforcing cycle. First, there is the creative, feasible idea. Second, its practical application. Third, its diffusion through society (p. 27)." Teacher education about technology is, thus, about change - about the ideas, the applications, and the diffusion of technology, the engine of change.

Today's technology creates a context of change. Within this context, teacher education frameworks designed to support an established system must give way to teacher education frameworks which teach about change - about its existence, its implications, and about how one participates in the change process. Designing an educational response to technology through appropriate teacher education is to plot a course toward change. Lessons from a brief history of teacher education related to introducing and promoting technology in schools suggest that teacher education for change must consider each student's predisposition to change and view responses to technology as part of a change process not a set of outcomes.

A Foray Into History

Phase 1 (1982 - 1985): In 1982, the voters of Albuquerque passed a bond providing Albuquerque Schools with five million dollars to place computers in all its schools and train its teachers. Drawing on a long tradition of collaboration, the school district and faculty combined resources. University faculty (UNM) and funded computer education resource teachers (CERT) collaborated in the design of a four semester-hour module offered at designated sites and times throughout the district.

Completion of the module was theoretically voluntary. However, the district mandated that all students were to receive computer instruction, and teachers were not allowed to teach with computers until they had completed the coursework. Bond money supported instruction while UNM faculty provided the opportunity to obtain university credit. For those wanting graduate credit, faculty supervised additional assignments. UNM created and filled a tenure-line faculty position in technology to support district efforts.

At the conclusion of Phase 1, 75% of all secondary and 95% of all elementary teachers had completed the four semester hour module which focused on computer literacy. Lip service was given to curriculum integration although mastering the mechanics of computers assumed ascendancy. Completion of this phase did not, however, result in widespread computer use. Many of those completing the course expressed continued anxiety and little insight into its educational implications. Pockets of innovative users did occur with teacher leaders emerging to take building level responsibilities at some sites. Some schools designated teachers to take over computer instruction relieving others of the responsibility.

Phase 2 (1985 - 1987): As the initial funding drew to a close, UNM faculty interested in technology assumed responsibility for teacher education. This took the form of designing graduate coursework on a variety of topics, continuing support of on-site classes throughout the district but in a diminished number, an effort to educate faculty in the hopes that computer education might become integrated into ongoing courses, and a plethora of on-site workshops as well as guest appearances in UNM courses.

This phase was perhaps the most dissatisfying one, beset by frustrations and disappointments. In preservice programs, the study of technology became almost an afterthought. While faculty gave conceptual importance to the role of technology, they made little if any effort to integrate its use into preservice coursework. Faculty interested in technology were asked to make guest appearances leaving many of us feeling that students were left with the impression that technology was something coming but not currently relevant. For potential leaders in the schools, graduate coursework was offered but was not part of an organized program for future technology leaders. It was hidden within the frame of established programs. On-site workshops, while relevant, were short and there was no frame for follow up. It became increasingly difficult to sustain enthusiasm.

Phase 3 (1987 - 1991): To overcome the hiatus of Phase 2, UNM faculty implemented three courses of action. The first was spurned by a district decision. The district implemented a policy whereby all new hires must either have completed a course in computer education or sign a waiver that they would do so during their first year of employment. This provided the backdrop for designing and requiring a three semester hour course specifically for preservice teachers. General faculty consent to this requirement was founded more in resignation than enthusiasm. Yet, for those interested in promoting the use of technology within the curriculum, it at least provided a forum for teacher education beyond the short guest appearances of Phase 2.

The second effort attempted to bring together those faculty interested in technology through the development of an interdepartmental graduate program. University structures impeded this effort leaving interested faculty unable to answer questions of administration, admissions, and degree granting responsibilities No such program was ever implemented.

· The third effort was the writing of a proposal for a corporate grant of equipment. The grant described a theoretical frame and a research agenda for the education of preservice teachers in the use and implementation of computers in education. However, since the grant was submitted by Committee, the structure of department politics prohibited the emergence of a principal investigator. A cumbersome number of meetings resulted in little more than a demand for more planning. When the perfect "plan" that met all agendas never emerged, the theoretical framework and the research agenda were never realized. Individual faculty did, however, make productive use of the available technology.

Lessons from History

Although each of the participants in this history might take a multiplicity of lessons from it, I would like to describe several lessons which guide the fourth phase on which we are now embarking.

About the Players

Teacher educators teaching for and about change must recognize that their primary preoccupation is to foster what Thomas Kuhn (1970) calls a paradigm shift - a gestalt shift in perception. A paradigm, he asserts, is a set of often unarticulated assumptions, beliefs, and values about the way the world works and a concomitant set of problem-solving exemplars. These exemplars are the tools, conceptual or actual, which a community of thinkers brings to bear on the solution of a problem. Teachers, perhaps more than any other professional group, enter teaching with an image of what teaching is—a paradigm. Teaching teachers about technology demands that their fundamental ideas about teaching undergo change—a paradigm shift.

There are no clear strategies for promoting such shifts, but a few guides may be found in the literature on adult (Sheehy, 1976; Levinson, 1979) and teacher (Katz, 1972) development. Most preservice teachers fall into two categories - the younger student entering their first career and the older, career shifting student. The literature, for instance, characterizes both these groups as primarily preoccupied with entrance into an established profession. In short, they are not candidates for professional change. Graduate students, on the other hand, are likely to have reasserted their commitment to being teachers but dissatisfied with the status quo, desirous of contributing to their profession. They recognize the need for change and seek knowledge to equip them to respond to change.

Teacher education for change, then, must beware of seeing all teacher needs as the same. Wholesale teacher education efforts like those described in Phase 1 are not likely to achieve their goals. The newer teacher and the preservice teacher will take new knowledge and reshape it to fit their existing paradigm. Others will reject new knowledge. A few will respond with enthusiasm and join a small corps of innovators. Workshops and guest lectures as described in Phase 2 are equally likely to fail. A paradigm shift necessitates a radical shift in perception. Short, isolated presentations do not precipitate the kinds of anomalies and crises in practice that result in challenges to long held systems of belief.

Teacher educators must shape their courses to respond to the needs of their audience. Thus, at UNM, the required preservice course does not teach about technology as a revolutionary force. Rather, we have placed our primary emphasis on how technology can support educational goals using the curriculum integration model. We no longer view the course as a mission to promote change but as a mechanism to engage perspective teachers with technology in a way that leads them to explore it when they enter schools. We concentrate on modeling how technology might be used, asking students to reflect on their experiences and draw lessons for their own practice. We know we are succeeding. Teachers in local schools involved with technology tell us that it is these new teachers who are the ones asking to have access to technology and for help in designing lessons. At UNM, we have learned to see these on-site innovators as allies and colleagues. They are among the most important agents of change. We have worked to build bridges with them, find ways to support their efforts, and shape graduate programs that meet their needs.

These innovators and similar graduate students seek change. They are more likely to have a set of experiences and challenges through which to view the potentials of technology. For this group, the challenge is not to create an environment for change but to find ways to assist the change process. The problem here is that a clear image of the implications of technology is not available. As the society as a whole wrestles with finding responses to technology, the design of an educational response must be a process rather than an outcome. Thus, we are designing graduate programs which emphasize theoretical studies of technology including the relationship of technology to change, to society, to cognitive processes, to discourse forms. We are attempting to design courses which do not teach answers but develop collaborative models for designing practices and promoting change. These courses attempt to promote environments which foster faculty/student collaboration and exploration, modeling change processes and possibilities as opposed to prescribing contents and practices. Such programs require sustained structures which are not diluted by the agendas of broader, existing graduate programs. And once these students finish their studies, we have found that we must retain contacts with them. As their paradigms shift, they are at risk of a sense of isolation from their other colleagues. We ask them to teach courses for us, to participate in our courses, and to join us in collaborative research and curriculum development projects.

All that pertains to students, also pertains to faculty. University faculty can be integral to the change process, promoting attitudes, knowledge, and the ability of teachers to integrate technology into the educational process. Yet, all faculty involved in teacher education are not ready or willing to integrate technology or teach for change. The faculty bring a diverse background of scholarly activity. Any faculty is plagued by a set of competing agendas which reflect the competing agendas of the society as a whole—restructuring, cultural diversity, literacy, bilingualism, and relearning. These competing agendas lead to conceptual endorsements while simultaneously creating "programmatic" and "implementation" roadblocks in respect to technology. One lesson that can be gleaned is that all faculty will not nor do they need to be part of efforts to promote technology and teacher education. Forcing faculty not ready to teach about change leads only to tokenism, that is, providing forums for students to have only brief encounters with technology that lead to anxiety rather than insight. Instead of asking all faculty to enter into technology, faculty interested in technology must find each other, form collaborations, and find intersections with others as time and need allows. They must become agents of change, not revolutionaries chasing windmills.

About the Process

For Hegel (1956) and Marx (1906), change is best understood as a dialectic - a dance between thesis, antithesis, and synthesis. For both, the thesis is what exists, but what exists has inherent within it its own negation - a set of internal contraditions (the antithesis). Any system framed by the thesis will attempt to cope with its contradictions by creating a new synthesis which then becomes the next thesis. For Hegel, the dance of the dialectic is defined by ideas. Thus, change is best understood by studying how each idea shaping the affairs of man finds its internal contradictions and gives way to the next guiding idea. For Marx, on the other hand, the dance of the dialectic is better understood by the relations of man to his environment, the means of production. As the institutional structures built upon that environment find their negation, new means of production arise to define new institutional structures.

For this author, neither Hegel nor Marx have captured the essential dialectic for it is the dialectic not of ideas or of environments that shape human affairs. It is the dialectic between our ideas and our experiences that create new systems. Even the best idea will find contradictions in experience, and every experience shapes our ideas. There will always be unintended consequences for well intentioned acts just as there will always be unintended consequences inherent in the best shaped ideas.

Hegel believed he had found the end of history in the perfect idea of democracy, and Marx believed he had found the end of history in communism. So far, neither vision of the end of history is upon us. For me, believing in the need to create a "plan" is as futile as believing in the end of history. Voters who passed a bond issue to bring technology to schools supported a plan of action that turned out to be a beginning not an end. Faculty who insisted on a plan before implementing an idea created an environment of no action.

Phase 4: Moving toward the Future. As teacher educators at UNM, we are currently moving not toward a plan but a process. This movement is taking the form of an interdisciplinary group of interested teacher educators who have come to realize that the institutional requirements of the university departmental structure can not be bent to support an interdepartmental program. Thus, we have requested reassignments to a semi-autonomous subset of one department. Our impulse has shifted from creating a revolution to developing a process that promotes a context for change. We have challenged ourselves to pursue research, collaboration, and coursework design in support of a process of investigation rather than an agreed upon agenda.

As a group, we have profited from a recognition that teacher education practices must be geared not only to the process of change but to the developmental readiness for change of our students. The required preservice course is under constant revision. We meet regularly as a group to reassess and restructure the course. Each of us teaches a section using the same syllabus even though it may not be at the top of our individual agendas. In this way, we remain steeped in the realities of preservice education. We have created a graduate program in technology that will hopefully be in place by the Fall of 1993. The program of study is built around a cluster of courses designed to address leadership and mentorship within schools, theoretical frameworks, the forms used by technology to structure information, and applications to particular disciplinary and transdisciplinary practices. In addition, we plan to structure as many of these programs as possible around cohort groups that might continue to support each other after completion of the program.

We have learned that teacher education about technology is really teacher education for change. Rather than teaching established outcomes, we need to teach about a process informed both by well-formed ideas and the realities of action. That process should have as its goals 1.) the creation and support of leaders who work both in the schools and in the university, 2.) the creation and support of collaborations that help bridge theory and practice, the possible and the ideal, and 3.) the fostering of both researchable ideas and testable actions that lead to change and replication. We are learning to educate for change in a changing world.

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Accommodating students' learning styles with microcomputer software

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Although many teacher education students are exposed to the use of computers in education during their preservice teacher preparation program, most of the effort is often invested in the technical or "operational" aspect of educational computing. Another very important aspect of educational computing is the match between the learning strategy used and the learning style of the student. For new teachers as well as experienced teachers who are beginning to use computers in their classrooms the issue of compatibility involves more than assuring the software selected will run on the machines available; it is also a question of matching teaching and learning styles.

Communication is the basis of learning. But each person expresses himself or herself in a distinctive way depending upon culture, intellectual capability, and academic preparation. With this vast diversity in ability, it is amazing that anyone can communicate feelings, facts, and skills. In traditionally structured schools, a student fails if he or she does not create a product which displays measurable evidence of acquired knowledge. Usually a student whose style parallels the teaching style of his or her instructor is considered intelligent. Some people are more effective at understanding facts and emotions through the written word, yet others comprehend information better through the creation of an artistic nonprint product. Schools measure students' intelligence with subject matter that emphasizes abstract, verbal, and rational modes of processing information. The student who learns more effectively through the concrete, tactile, and intuitive modes is at a distinct disadvantage (Kane 1984). The various methods by which people acquire information and display their intellectual accomplishments can be referred to as learning styles. Keefe (1982) defined learning styles as "characteristic cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (p. 44).

Is learning more effective when students are presented with information through their preferred styles? Dunn (1990) believes that once a student learns how to study with the particular characteristics of his learning style, there is a significant increase in achievement, a reduction in school dropout rate, less stress exhibited in class, and a more positive attitude toward school. As a result teachers try a variety of techniques which increase student enthusiasm for subject matter. Renzulli and Smith (1978) recommend stimulating academic interest through varying the presentation of information with educational media. Most children are exposed to and learn from nonprint materials such as pictures, models, television, and films at an early age. The potential of technologically sophisticated nonprint media to teach children is documented in research studies.

The microcomputer is a dynamic and powerful teaching tool already established as necessary in an academic environment. Many excellent software programs create a positive learning environment that stimulate students' creative thought processes in ways unheard of in the traditional classroom (Sylwester 1990). But as every teacher knows, not all computer software is worth the time it requires to use. With the microcomputer becoming more commonplace in many schools, students are no longer automatically enthusiastic about learning via computers. Even award winning software may not appeal to all students because its structure does not address their current intellectual interests. Therefore, it is imperative that a teacher not only be aware of students' learning styles prior to assigning specific software, but also he or she must identify which styles are stimulated through the presentation of a particular software program.

There are particular characteristics of individuals who exhibit behaviors peculiar to each learning style (Gregorc 1982, McCarthy 1990, Sternberg 1990). For example, Gregorc classifies learners into four basic categories—concrete sequential, abstract sequential, abstract random, and concrete random. Gregorc's delineator requires the student to rank words which identify how he or she interacts with other people and with learning situations. Unlike other delineators which attempt to assess environmental conditions or media preferences, Gregorc's measurement tool is concerned primarily with the individual's self perception.

Concrete Sequential—Characteristics

- Possesses extraordinary physical sensory abilities
- May have a photographic memory.
- Processes information in a linear, sequential format
- Needs to know objectives and directions
- Likes hands-on and practical, realistic problems
- Enjoys detail and data gathering
- Is a perfectionist
- Transmits knowledge via production of a physical object
- Is creative by improving on another person's product
- Resistant to change—change comes in incremental steps
- Can be diplomatic yet dictatorial at times
- Expects rewards, recognition, or compliments for a good job
- Responsible and dependable
- Likes ordered environments, predictable, and stable
- Likes to work by himself
- Prefers a quiet and busy environment

Some software programs encourage the type of intellectually stimulating environment a concrete sequential prefers. Any program that permits a sequential thought process and allows a hard copy or disk copy of a finished product resulting from the interaction of student and computer would benefit this child. Programming languages which create graphic or textual displays immediately from commands are preferable. Since this type of learner also enjoys researching for reports, many of the electronic reference sources and telecommunication networks allowing a child to search a large database would also be received favorably by this type of student. Likewise, concrete sequential students are drawn to games which requires him or her to follow a specified set of rules and focus attention on detail.

Abstract Sequential—Characteristics

- Prefers nonphysical world of thought, mental manipulation
- Sequential thinking in a branching fashion
- Very analytical
- Mentally outlines, compares and categorizes data
- Change comes slowly and with a lot of weighing of facts
- Collects items that symbolize knowledge
- Prefers orderly, quiet atmosphere for learning
- Continually acquiring knowledge
- Particularly adept at sensing differences in a situation
- Takes the work of others and adds to it by analyzing
- Represents concrete reality in words and signs
- Relies on expert opinion and fact
- Is highly verbal
- Prefers to learn by himself or herself
- Transmits knowledge through the written or spoken word

Certain software programs encourage the abstract sequential learner to use a microcomputer. Their need to substantiate findings could be satisfied with an electronic reference source or a telecommunication database. Deferred programming enables this students to mentally manipulate commands in order to produce a desired graphic or textual display; a hypertext program also encourages an abstract sequential to create a product showing the synthesis of his or her research efforts. There are various software games which enable this type of learner to mentally manipulate objects or ideas; these programs appeal to the imaginative talents of this individual yet still allow a child to approach learning in a sequential manner.

Abstract Random—Characteristics

- Processes in a random manner (non-linear and multi-dimensional)
- Focuses on relationship between persons, places and things

- Has a strong ability to recollect
- Is highly impressionable
- Relies on innate instinct about humans and social situations
- Is able to change only when emotionally involved
- Is very emotional, imaginative, and holistic
- Collects music and plants to create a positive environment
- Rebuilds an existing object into a more refined state
- Must interact with another person to learn
- Believes that a person or event makes a difference
- Prefers a visually and auditorially stimulating environment
- Prefers self discovery

Since this child requires verbal interaction with another student in order to process the information being presented to him or her, it is imperative that the abstract random individual work with another student at the microcomputer. In a traditionally structured school environment, communication between students while formal instruction is in progress is discouraged, thereby reducing the ability of this type of student to absorb information. Snow and Lohman (1984) indicate that the abstract random student should be paired with a student possessing the same learning style initially, and then as the student becomes more proficient he or she would be paired with a student who has a different learning style. Although some teachers may express concern about noise level when children work together, these students must communicate with a peer. Teachers avoid a problem by placing paired learners away from individuals working at computers, and they should also emphasize the need for subdued voices during discussion.

There are particular types of software programs which enable an abstract random learner to explore the power of a microcomputer. Wordprocessing and graphics software allow this student to express feelings through emotionally stimulating stories, poems, or visually descriptive graphics. A telecommunications network which emphasizes student interaction with other students across the nation or around the globe would appeal to the people-oriented abstract random.

Concrete Random—Characteristics

- Uses intuition to study the concrete, sensual world
- Utilizes a semi-linear progression in thinking
- Is a quick and impulsive thinker
- Does not like directions
- Likes exploring unstructured problem solving situations
- Studies methods in dealing with persons and places
- Produces original and unique items
- Takes risks and invents
- Needs a stimulus rich environment with freedom
- Likes to work with others as a leader
- Likes to experiment for himself in a group
- Does not consult outside authority
- Loves competition
- Thrives on change in self and environment

Like the abstract random, the concrete random must interact with another student in order to process information. Since these individuals tend to be the dominant force in a group, pairing this student might pose a challenge for a teacher when assigning microcomputer activities.

Certain types of software programs appeal to the concrete random learner. Any wordprocessing activities that permit this learner to work with other class members to produce a newspaper or research document would fit his or her learning style. Since this child actually relishes competition with peers, a teacher could select software that encourages the acquisition of skill or knowledge yet satisfies a desire to compete with fellow concrete randoms. These students also thrive on solving problems, and there are software programs to stimulate this talent for creating strategies. Because the concrete random needs to communicate with other students to solve a problem or collect data on a given subject, teachers should consider using telecommunication networks that require students to interact with other students either nationally or internationally to solve a specific problem or to conduct studies.

Adapting Software For All Learners

Preservice and inservice programs that help teachers attend to learning style issues when designing computer-based experiences cannot approach the issue as a simple learning style-educational software match. Teachers do not have access to an unlimited library of microcomputer software which would appeal to such a variety of learning styles. Therefore, it is imperative that an educator be able to use available software for all students regardless of styles addressed by that software. Most lesson plans can be adapted to meet each student's needs if a teacher prepares in advance strategies he or she will use in order to make the microcomputer lesson a rewarding and academically valuable experience. Although the microcomputer can provide a vital contribution to creating a positive environment for all students, it is also capable of perpetuating only those learning styles to which it already appeals (Gardner 1983).

One program used in many schools to stimulate thinking skills is The Factory (Sunburst). This particular program requires mental manipulation; it also demands that a student use linear thought processes. The abstract sequential learner would likely find this software program enjoyable and challenging when it is used as suggested in the teacher's manual. However, lack of an actual physical object and the necessity of thinking in linear progression may frustrate students who possess other learning styles. A teacher could assist other students encountering difficulties while using The Factory and further enhance the experience received by the abstract sequential learner as well. Some illustrative examples are provided below:

Abstract Sequential

1. The teacher makes a model product on the computer and students identify the procedure involved in its creation.
2. Students work with the computer program to identify the machines used to create a product.
3. Students make their own computer product and compare and contrast the machines other students use to create the same product.
4. Students design a product with different shapes such as circles and octagons and determine the degree of difficulty in deciphering the procedure.

Concrete Sequential Accommodation

1. Children individually verbalize the steps of making a peanut butter and jelly sandwich.
2. The teacher creates construction paper models of a product and each child follows along with the teacher's directions as he or she alters its physical appearance.
3. Children create their own product with paper models; other students must identify steps.
4. Children create a simple product first on the computer and identify the steps necessary to replicate the computer's product.

Abstract Random Accommodation

1. Children verbalize the procedure their partner uses to make a peanut butter and jelly sandwich.
2. In a group of four children, each child adds one dimension to the computer product in some way and then a fifth child describes the procedure his or her peers used.
3. In pairs the children verbally identify how the computer model was created.
4. In pairs children discuss how other machines not currently available on this particular program could be added to create a more unusual product.

Concrete Random Accommodation

1. Children manufacture a peanut butter and jelly sandwich with random instructions to emphasize need for specific sequence of events (directions).
2. With construction paper models children follow along with a teacher in identifying the steps used in altering the products' physical appearance.
3. In groups of four, children collaborate while making a model product on the computer and challenge other groups to determine the procedure (competition).
4. Students brainstorm other types of products that the computer programmer might consider adding to The Factory to increase the level of difficulty.

Another popular software program in many schools is Oregon Trail (MECC). In this program students work in groups of five who travel the Oregon Trail in the 1840's. This program possesses elements of problem solving and competition; a student must have some knowledge of historical events prior to using this simulation. Concrete random learners would find Oregon Trail an effective learning experience, because it emphasizes the element of chance and the challenge of problem solving. Other features which could be emphasized by a teacher increase appeal for other children who learn best through other styles.

Concrete Random

1. Students can calculate the number of points they receive at the end of the program, and they can determine the success of their hunting ability.
2. Students design a better wagon to insure the party's safety during the journey.
3. Students identify a comparable journey today and determine the risks travelers face. They could also cite benefits gained from that adventure.
4. Students speculate about other methods by which a person could extricate himself from a predicament while on the real trail during the 1840's as compared to the computer programmers' solution to a problem.
5. A group of students cite the responsibilities of wagon master in relationship to other members of his or her party. They should identify the methods by which a leader motivates and convinces teammates to accept one course of action over another.

Concrete Sequential Accommodation

1. Students and teachers cook foods prepared through pioneer methods.
2. Students measure cardboard boxes and form a wagon bed. They must add necessary provisions made from sacks stuffed with newspaper and use cardboard boxes to show approximate square footage in a covered wagon.
3. Students make a salt, water, and flour map showing the mileage and terrain to be covered from Independence, Missouri to the Willamette Valley in Oregon.
4. Students make a diorama of one of the events they feel was important during their journey west.
5. Students create a time-line showing their progress as they cross the prairies, mountains, and rivers.

Abstract Sequential Accommodation

1. Students read several pioneer diaries and compile a report about common occurrences of life during the 1840's.
2. Students identify five causes of death and illness which were actually common for travelers on the Oregon Trail.
3. Students speculate about why so many people died of cholera during the 1840's while on the Oregon Trail.
4. Students calculate how to best spend their money to meet the demands of their journey as they travel as a carpenter, a banker, and a farmer. They should identify the computer programmers' knowledge about each of these occupations in this program.
5. Students outline their experiences while on the trail and identify reasons why they succeeded or failed to arrive in Oregon.

Abstract Random Accommodation

1. Students keep a group journal of their Oregon Trail journey and write it as if they actually had traveled in the 1840's.
2. A group of students collect several songs that were popular in the 1840's and plan a campfire session for the class; they can create a song that might reflect their own feelings about their journey.
3. Students role-play an incident from their experiences as they journeyed to Oregon.
4. Students create a positive eulogy about a member of their party who died while on the journey, or students identify the positive contributions of each member of their party which allowed them to survive.
5. Students write a newspaper article encouraging or discouraging other citizens from making the journey west.

An effective teacher attempts to provide a number of experiences which encourage all students to become enthusiastic about subject matter under study. By understanding the strengths and weaknesses of their learning styles, students can develop an appreciation for their peers' approaches to understanding information and to creating a product which displays their level of knowledge (Hand 1990, Brandt 1990). Locus of control is also an important factor. Pascal (1971) found that students' attitude toward subjects improved when they were permitted to select the method by which they could learn required information.

Teachers must be aware of their students' learning styles in order to develop life-long learners who enjoy increasing their knowledge base, not because they are required to do so, but because they want to keep abreast of developments. Computer software can never function alone as sole sources of information for children because only a human teacher can manipulate learning experiences using various forms of media to meet the emotional, learning, and sociological needs of all students in a classroom. This fact of professional life is not always reflected in the training teachers receive. If they learn no more than how to operate the current generation of computers and a general procedure for selecting educational software, teachers are not likely to integrate technology into the curriculum in ways that meet the needs of all students. And when some students are less than enthusiastic about a computer-supported lesson, the teacher may conclude that computers in the classroom are not that beneficial. It is in the interest of all concerned, including educators who support the wider use of technology, to include coverage of the issue of learning styles in preservice and inservice programs about educational computing.

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The legend of the qualitative/quantitative dualism: Implications for research in technology and teacher education

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> *The danger of our dialogues was hidden in the language itself, not in what we discussed, nor in the way in which we tried to do so.*
>
> Martin Heidegger

I have argued elsewhere (Tellez, in press) that the discipline of teacher education and technology has the unique opportunity to begin inquiry anew with refined research agendas while leaving behind the poor methodology which has historically plagued teacher education research. In this paper, I argue that we are not only poised to leave behind poor research, but that we can responsibly remove a false wall recently erected by education researchers: the qualitative/quantitative dualism (QQD). By showing that the QQD, which has divided the faculty in many colleges of education and prompted dozens of articles arguing for the use of one or both strategies, is a vestige of Kantian thinking, recently dismantled by contemporary philosophy. I will argue that teacher education and technology can now transcend the debate and advance a research agenda free of its limiting constraints.

The rift in qualitative and quantitative methods of describing, predicting, even controlling education has grown wider in recent years, in spite of attempts to "close it down" (Smith & Heshusius, 1986). It seems that some of those who study human behavior have reached an uneasy truce, yet for many researchers it appears that the division is deeper than ever. Educational researchers, in particular, have now developed two separate lines of research, often existing in the same department, battling for graduate students who will use their methods. Why does this dualism come so forcefully now and why do we continue to take so much notice of it? In this paper, I will argue that the use of the QQD in the maneuvers for primacy in describing the reality of teaching and learning is not only a false one but one that blocks us from other vocabularies, which may be better at describing what people do in education. At the heart of my analysis is the view that words and numbers are two of our representational resources, and that both are metaphors (in the broadest sense) for describing action. In unpacking the QQD and suggesting a world free and untethered from it, I will make the following points:

I. Early in this century, Dewey forcefully attacked the dualisms of his day (child vs. curriculum, knowing vs. doing, theory vs. practice). His arguments are still powerful and have special meaning for the QQD.

II. Modern theorists who argue for the primacy of quantitative data over qualitative data have made a mistake that Kant made over 300 years ago, namely, the distinction between analytic and synthetic truths.

III. Quantitative researchers may argue that numbers get us closer to the truth than qualitative inquiry. In fact, quantitative research depends on a few very ambiguous words to describe its findings.

Whereas this paper may have implications for disciplines beyond teacher education and technology, I hope to point out that there exists a special emphasis for our work, not because our investigations are considerably different than others in education, but because we have the advantage of a short history (i.e., a history easy to reshape and reconfigure).

I.

Dewey sprinkled his writings with numerous attacks on dualisms. It is, therefore, surprising to notice the extraordinary health of modern dualisms. Educational researchers can be heard talking freely about the theory/practice split, the cognition/emotion dichotomy, left brain/right brain, and, of course, the QQD. Phenix (1966) cogently describes Dewey's attack on dualisms, noting that Dewey warned his contemporaries that a focus on dualisms would encourage "the neglect of the more important connections and relationships which the solidification of these general categories encouraged" (p. 40). In essence, Dewey used the concepts of nature, experience, interaction, and continuity in his war on dualisms. He maintained that it was inappropriate to chop nature up into two parts (e.g., living/non-living, real/surreal). The world is a constant flux, ill-suited for easy categories, and that while dualisms may help to spur talk about the world, they do not necessarily help those who talk about it to understand it better. Bernstein (1986) pointed out that "Dewey sought to unmask the tendency for philosophers to reify and hypostatize changing fluid, functional distinctions into metaphysical and epistemological dichotomies" (p. 263). In this respect, we are reminded that our language may decide for us how we are to understand our environment and therefore limit our understanding of it, although this is a point of much dispute.

A common dualism in teacher education and technology research spins on the purported difference between *abstract* "theoretical investigations" in technology and *concrete* software development. This dualism is false namely because one cannot test, evaluate, or develop computer software in a theoretical vacuum. Any researcher seeking to apply a prescriptive treatment to an educational problem cannot do so without an undergirding belief driving development. Even the most "applied" research has a theory on which to base expectations, even if that theory resembles what Maxine Greene calls a personal landscape (Greene, 1978). Nor can one develop a theory or write a theoretical paper without considering application. The world cannot be made to disappear when we develop theory. Every theoretical idea has as its base the experience of the nearby environment. We should also be reminded that theory has its place and that a fascination with theory may distract us from finding new ways of thinking about the world. Santiago Ramon y Cajal, the founder of neuroscience, wrote early in this century: "To observe without thinking is as dangerous as to think without observing. Theory is our best intellectual tool; a tool like all others, liable to be notched and to rust, requiring continual repairs and replacements" (1937, p. 155). The notches and subsequent repairs in a theory are caused by interaction and testing in the experimental world. The concrete often rubs theory the wrong way, and the experimenter's task is to modify theory with the "backtalk" of the environment. The concrete cannot exist without the abstract nor vice versa.

In short, Dewey argued that the world does not exist in a binary mode. I suggest that the moment a community of inquirers believes a dualism exists, that dualism should be interrogated and shown to be untrue. Such proof is typically not hard to find.

II.

The second argument leading to the dismantling of the QQD hinges on the analytic/synthetic truth distinction. This debate, much older than the QQD, contains one of the key ingredients necessary for dismantling the QQD. It was Kant who first proposed the analytic/synthetic distinction, which he suggested cleaved sentences into two distinct classes: those whose truth depends on facts of matter (synthetic) and those whose truth depends on facts of meaning (analytic). For Kant, analytic propositions are (a) those in which the predicate is "contained in" the subject, (b) those in which the connection between subject and predicate is one of identity, (c) those which one cannot deny without being involved in a self-contradiction. Conversely, synthetic propositions are (a) those whose predicate not contained (b) not identity (c) and those in which one can deny without being involved in a self-contradiction. A common example of an analytic statement is "No unmarried man is married." One needs not appeal to the world for verification of the truth to the statement. No empirical check is required. It is analytic. However, the following statement, "Snow is white," cannot be confirmed without an appeal to facts (observation) found in the environment and is thought to be synthetic. Quine (1953) showed that this distinction is indeed false by pointing out that there are truth statements that fall into different divisions within what had once been considered analytic statements. Harris and Severens (1970), in an introduction to Quine's "Two Dogmas of Empiricism" wrote:

> Quine distinguishes between two kinds of supposed analytic statements: those which are logically true (or true by virtue of their form alone) and those which are true by virtue of meaning, not logically true but true because of their nonlogical content. The first kind invariably remain true under any uniform substitution for their nonlogical expressions. For example, "Every rose is a rose" remains true when "turtle" is subtituted for "rose" therein. Logical truths are truths which retain their truth no matter what systematic substitution is made for their nonlogical terms. On the other hand, the latter kind cannot be characterized so easily. Thus although "No bachelor is married" (which is not a logical truth , or true by virtue of its form alone) can be made into a logical truth by substituting "unmarried person" for bachelor on the basis of their purported synonymy, the matter is not closed. For the notion of synonymy is every bit as mysterious as is the notion of analyticity. Characterization of the second class of analytic statements failing thus, the notion of analyticity itself remains incompletely analyzed. (pp. 23-24)

For the purposes of this discussion, however, it is important to focus on Kant's "mistake" in suggesting analyticity for mathematical statements. Kant maintained that a priori knowledge (the type needed to verify the truth of analytic statements) is independent of experience. Whereas he did believe that though all knowledge begins with experience, he did not suggest that all knowledge arises out of experience. Kant maintained that it is necessary to learn the concepts "5","+", "7", "=", "12." However, once learned, it is not necessary to rely upon experience to judge the truth of "5+7=12"; such knowledge is independent of experience and is therefore analytic. Quine illustrated that it is really impossible to characterize purely analytic statements. The analyticity of mathematical statements is challenged by the fact that there is no such thing as an analytic statement. Mathematics does have the illusion of being purely logical, and therefore analytic, but the way in which modern social scientists interpret this falsity is what gets them into trouble. The illusion that statements which involve numbers are often analytic (ones which rely only on logical terms to determine truth) has led many social scientist to believe that once a number is ascribed to a phenomena, the truth is fixed, no longer in need of further experience for verification. For example, a researcher interested in Knowledge of Technology may develop a measure (operationalized) that reflects this ability. (Let's call it the KTS). After scaling the instrument and computing scores, knowledge of technology "becomes" 56 for subject number 12 while the mean for the sample "becomes" 58.96 (KTS=58.96). Following Kant, this move is often thought to stop the continuing need to define knowledge of technology. Conversely, if knowledge of technology is described using more words, the meaning is thought to be synthetic (Does knowledge of technology really mean the words I thought it did?). It is very common for education researchers to uncover a construct, ascribe a numerical value to it, and proceed as if the "truth statement" needs no further verification. Of course, the social scientists have their own system for "proving" the analyticity of statements like KTS-56.78; that is, the ritual of operationally defining constructs. Once a number represents a construct, it is tempting to believe that the construct has been defined and the "truth" can then be sorted out.

Mathematical statements are not analytic because the analytic/synthetic distinction has been dismantled; therefor, the notion that numbers are somehow closer to the truth is a myth. Nor can we say that statements using words are synthetic or analytic. The truth of any statement requires a combination of logic and experience; every statement is a negotiated, temporal "truth."

III.

The third attack on the QQD is supported by Miller and Fredericks (1991) who argue for the value of indeterminacy (the fact that we all develop our own individual translation of what we believe to be common terms) in research in the human sciences. They argue that even when we believe that we have developed quantitative research, we inevitably find ourselves falling back on words, and thus to indeterminate meanings. For example, a social scientist is interested in the relationship between a certain instructional method and student achievement. Of course, the meaning of "instructional method" and "student achievement" may be vague, ambiguous, or both. For the purposes of this discussion, however, it would be most fruitful if we assumed that all concerned had assented to the meaning of these terms by deciding how they could be defined.

The ceremony of educational research requires our researcher to operationally define the constructs used. Having done so and conducted the research, it is discovered that a correlation of .50 is found between two constructs. Miller and Fredericks argue that it is at this point that ambiguity sets in. Is a correlation of this magnitude "strong" or "weak?" Certainly it is stronger than no correlation but it is considerably weaker than a perfect relationship. The terms we inevitably must use to describe this number (.50) are indeterminate; that is, we all must appeal to "meaning" when we interpret "strong", "weak", or "somewhat strong."

All those who know the ceremony and ritual in social science know the next move well: statistical significance. This strategy, however, does little to reduce the reliance on words even after we employ sophisticated mathematics to be "sure" of our results. Miller and Fredericks write, "In this version of trying to reduce methodological indeterminacy, one agrees that even though the correlation does not remove (or 'explain') the problem of accurate translation, the 'amount' that it does remove is (statistically) significant" (p. 365). Thus, unless we limit ourselves to a perfect correlation, it is still with vague words ("a low or high level of significance") that we must discuss the results.

The problem cannot be solved with an appeal to more advanced techniques of statistical analysis. Again, while perhaps a larger percent of variance is "explained," some portion is left "unexplained." Researchers may now be able to describe how other variables or factors influence one or more other variables, the problem of significance has not been attenuated nor is there ever a guarantee that the model used to account for the variance is fully specified. Most quantitative researchers, of course, would not argue that the data can completely explain a phenomenon. However, most would argue that as a result of the experiment or data analysis, the "truth" is closer at hand.

Conclusions

As part of a larger critique of Enlightenment thinking, Richard Rorty has suggested that what now counts as science, that which is able to somehow stand outside the flux of experience, like a Philosophy which can stand outside the world with a "God's eye view," does not exist. Rorty maintains that the way we describe the world has a good deal more to do with our vocabularies than with any correspondence to reality. He makes clear that the rigid categories of the vocabularies that count as science or research often get in the way of alternative vocabularies. His question to an educational inquirer might be, "Are the representational resources (vocabularies) you are now using getting in the way of the use of other representational resources?" and avoid altogether the question, "Have you got it right?" The ironist teacher education researcher would focus on novelty rather than searching for the one best way to educate teachers, a fruitless venture, tantamount to asking "With better science and technology, we can discover how to produce the perfect teacher." She would use her resources trying to uncover what has been ignored instead of perfecting what we already believe to be a promising line of research.

Rorty argues persuasively that modern notions of "science", "truth", and "objectivity" have come to carry too much weight and that we rarely recognize the load. Rorty (1991) suggests that we avoid such categories and suggests that as philosophers and scientists we engage in "less talk about rigor and more about originality" (p. 12).

The QQD, in my view, has very much been getting in the way of producing alternative vocabularies about teaching and learning. Nietzsche called the truth a "mobile army of metaphors," and in educational research, our metaphors are constrained by the false bifurcation of the QQD. We have let one set of vocabularies get in the way of others; our understanding of teaching and teacher education can be improved by creating better metaphors, not a better science. Limiting ourselves to metaphors of numbers and words that are ambiguously "grounded" in reality limits us to a language in which we are forced to play a silly game of "my metaphors represent reality better than yours." It was Wittgenstein (1958) who proposed that language was like a game among a set of players. In his argument, he pointed out that in the language game it was impossible to develop the perfect game, that there was no point in trying to find the perfect language, primarily because the game (language) must constantly change. New rules, new pieces, and new players will dominate. The only rule that governs any change is that at least a few other players have to agree upon the changes. After that, it is a new game. By comparing language to a game, Wittgenstein maintained that players use the language as a tool rather than making the object of the game the development of a language. Those who study technology and teacher education now have an opportunity begin their inquiry with a de-emphasis on the tools while focusing clearly on both the nature of the game and the subjects of inquiry themselves.

While much of modern educational research is tied to the QQD, there is no reason why those working in teacher education and technology research must subscribe to previous categories. We must maintain a level of creativity and even subversion in our research efforts. The field is new, there is little tradition before us and the tradition that exists may not be one that we wish to build upon. Let me share an example that I find illustrative: I recall watching a short television spot about a new software development company. What surprised me most about the operation was the downright playfulness and spontaneity of those who worked there. Squirtgun fights erupted during meetings of the board, shenanigans of all sorts were easy to find, yet this small company had developed an amazing piece of software that had garnered the sizable market share for their product. The traditional categories (dualisms in part) of research and development had been blurred and the emphasis seemed not on getting the software right (although it comes to that eventually) but rather to develop new ways of looking at technology and how we could use it. In effect, they had come to develop alternative vocabularies. This kind of attitude toward technology and teacher education may point us in the right direction.

There are some signs that teacher education researchers are coming to understand the postmodern view of language (for a discussion of the implications of postmodernism in education, see Cherryholmes, 1989). In particular, I am encouraged by the recent work in the area of teacher research, mostly because teacher research offers a new way of finding out about the world (Goswami & Dixon, 1987). Because teacher researching developed in part as a reaction to traditional, quantitative research, it is not typically bound by the QQD. Teacher researchers tend to approach research in their own specific context by using whatever methods or vocabularies suit their needs. They fuse methods, create new terms, talk *directly* to students, observe them daily, and find conclusions about which they make no extra-worldly claims (they rarely claim wide generalization). What they often write or tell about in their research attempts is reminiscent of a story, and the story, as Barone (1992a, 1992b) has suggested, is powerful in both its ability to re-describe and empower.

In the attempt to create alternative vocabularies, I would recommend that teacher educators help preservice students engage in their own research questions that result in their own story, their self-description of what they hope to become as teachers. Technology, rather than being a discrete chapter in their story, might weave in and out of the larger narrative. In summary, the QQD debate should end, not because one methodology is better at finding the Truth, but because the distinction is a false one and the vocabularies created by it limit our ways of discovery.

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Instructional design + cognitive strategies = improved pedagogy

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Instructional technology carries with it many pseudonyms and a variety of definitions. For this author, it is a systems approach process: "a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication, and employing a combination of human and non human resources to bring about more effective instruction" (Commission on Instructional Technology, 1970, p.21). Today, one prominent view of human learning is cognitivism. Traditional cognitive science emphasizes thought processes and is studied as a collection of theories known as human information processing (HIP) theories. These theories consider how humans perceive, process, store, and retrieve information. The relationship, then, between cognitive science and instructional design (ID) should be of critical concern to educators. Assuming learning is a function of information processing, the most effective ID must take into account the learners' cognitive processes.

In general, any ID should consider the level of cognitive development of the learner. To facilitate learning, an ID should present information in an organized fashion that encourages the learner to recognize connections to previous knowledge. ID should plan for the processes of association and elaboration to occur.

Attention and perception are two HIP processes that should be considered in the ID process. Effective instruction should include a plan for getting and maintaining the learners' attention. Care should be taken to consider how materials and the method of instruction will be perceived by the learner.

Another cognitive construct that deserves consideration in the ID process is transfer. An understanding of the types of transfer and what conditions facilitate transfer are essential to the most effective ID.

Modern research suggests there are certain control processes a learner may engage to manage other HIP processes (e.g. attending, elaboration, recall, transfer). These control processes are called cognitive strategies; they allow learners to regulate their own learning. Gagne and Glaser (1987) group these cognitive strategies into three basic groups for the instructional designer to capitalize on. *Strategies for learning* are those which allow the learner to modify or control incoming information. Included in this category are strategies for attending (e.g. interspersed questions, statement of the objective), guides to comprehension (e.g. summarize, question, anticipate), and pattern recognition. When the ID embeds these constructs in the instructional presentation, these strategies for encoding contribute to improved learner performance. Often, these strategies must be overtly cued by verbal instruction. Encoding may also be positively influenced by some type of imposed organizational structure. Cognitive maps and frames are examples of effective organizational structures. Depth of processing, and thereby, encoding, is generally increased through strategies that support elaboration.

The second group of cognitive strategies advanced by Gagne and Glaser are *strategies for remembering*. It is difficult to separate these entirely from the encoding strategies since research suggests that the recall of specific words is heavily influenced by the context in which they were learned (Ormrod, 1990). These types of incidents are examples of encoding specificity, which, in certain domains, may work to the advantage of the learner. ID must allow for recall to be stimulated using these encoding contexts as cues to the learner. Instruction in isolated facts and rote memorization offer the learner little opportunity to develop necessary contexts for their learning and should be avoided in the ID process.

Problem solving strategies are the third strategy group discussed by Gagne and Glaser. These strategies tend to be highly content and domain specific. Strategies in this group force the instructional designer to consider the interplay between learner processing ability and learner knowledge structure. Consideration of misconceptions and transfer are critical to the ID at this juncture.

Most ID work is now routinely applied through a sequence of prescribed decision-making steps known as ID models. The vast majority of these ID models have grown out of a desire to apply basic research in cognitive psychology, developmental psychology, and motivational psychology to the creation of prescriptive theories, "rules" that teachers can follow which are intended to result in more effective learning by their students. Wildman (1981) argues that the process of ID ought to be conducted by individuals who have adopted a cohesive theory of learning to serve as the basis for the decision-making that is inherent within and among current ID models.

It is the belief of this author that the most effective applications of ID will occur as a result of shifting the focus of learning away from an external (teacher) locus of control to an internal (learner) locus of control. Learning, then, can be described as a generative process which causes modifications to internal knowledge representations. Given that learners construct knowledge structures, instructional designers should be familiar with cognitive processes and theory. ID then provides the necessary support for the learner as these processes occur.

Learners must eventually understand their own attempts to learn in order to control the process. Thus, the focus of ID must change from the traditional emphasis on what the teacher does to a new emphasis on what the learner is to do. Learners must shoulder a considerable amount of the responsibility for what is learned but the ID should facilitate each step of the learning process. Design work is necessarily involved in the process of teaching students how to learn. The task of instructional designers becomes more complex as they account for the information-processing activities of learners. Existing models take on new significance as ID pays greater attention to such critical issues as the need for learners to actively attend to relevant aspects of a given learning situation; the need for learners to make connections between new material and existing knowledge; the need for learners to recognize when new information doesn't make sense.

Task Analysis

Once learning is viewed as the growth of cognitive structures, an initial ID step is to make explicit the structure of the content to be learned. This component of an ID model is typically referred to as task analysis. Application with cognitive processing in mind requires designers to be concerned with the major information-processing tasks associated with the attainment or construction of knowledge structures as well as the prerequisite behaviors for complex performance. Creating an effective sequencing of learner objectives, deciding which aspects of learner prior knowledge are relevant to the existing task, and selecting a delivery strategy which best fits the information to be learned are other design issues that are influenced by the initial task analysis.

The structure of content materials has an important influence on learners as they attempt to create their own meaning and understanding from unfamiliar information. It makes sense, then, that the instructional designer must also understand the relevant structural aspects of a content in order to effectively select, produce, and/or modify instructional materials. For years, ID has recognized that there are powerful predictors of a learners' ability to learn new information: the degree of the relationship between inherent content structure, the nature of the learners' prior knowledge, and the way in which the new information is initially presented (Ausubel, Novak & Hanesian, 1978).

How content is organized should be a function of cognitive and ID task analysis which, in turn, would lead to the construction of instructional materials which display the essential features of the content and contain appropriate elaboration. Too often, the classroom instructional designer allows the instructional materials to dictate a content organization that does not conform to basic cognitive principles.

Designing Instructional Strategies

Just as task analysis is a key component of ID, so is designing instructional strategies. Commonplace ID models require the designer to first place the instructional goal within one of the four accepted domains of learning: intellectual skill, psychomotor skill, verbal information, or an attitude (Gagne & Glaser, 1987; Dick & Carey, 1990). The basic components of an instructional strategy are the same regardless of which domain is being addressed. There are, however, some distinctions in the organizational structure for each type of learning outcome that can be supported by specific cognitive strategies.

The design of instructional strategies for the attainment of *intellectual skills* should focus on both the way learners have organized their entry knowledge and the limits of their ability to store new information. These strategies should provide ways for the learner to link new information to existing knowledge. They should provide the learner with specific ways of reorganizing new information for storage along with relevant prior knowledge. These strategies will also increase the learners' ability to recall the new information. Instructional strategies for intellectual skills should present subordinate skills and concentrate on the distinguishing characteristics of concepts which combine to make the "rules". It is important to include irrelevant characteristics and address errors commonly made by learners. Designers should try to select examples/instances that are likely to be part of the learners' memory. Transfer will be enhanced if the ID progresses from familiar examples to less familiar ones and then to new instances. Practice should be tied closely to the conditions and behaviors set forth in the objectives and evaluation criteria. Feedback should be a balance of corrective and positive. Be cautious in evaluation of premature testing and of applying poor criteria for judging the quality of the skill development. Follow-through strategies address the iterative nature of ID by allowing corrective feedback after the posttest or additional instruction on specific subordinate skills.

The design of instructional strategies for *verbal information* outcomes begins with informing the learner of the objective. Try to summarize the objective using organizational structures previously used. Transfer will be facilitated by informing learners how they can use this information outside the classroom environment. The most important strategy in the presentation of verbal information is that the presentation occur within a meaningful context for storing and recalling the new information. Instructional designers know this as the process of elaboration. Gagne (1985) suggests the more detailed the elaboration, the greater the likelihood that the information will be stored in a logical place which will cue learner recall. ID should include practice activities that strengthen elaborations and cues and assist in establishing a more relevant organizational structure for the learner. Feedback should be straightforward. It should include the correct response and information about why any other response is incorrect. Evaluation strategies for verbal information should include appropriate recall cues. Follow-through activities for remediation may include additional elaboration strategies, expanded organizational strategies, or better motivational strategies. Cooperative learning situations may provide the learner with practice in recall and coaching, as well as enrich elaborations and meaningfulness.

ID strategies for skills within the *psychomotor* domain generally involve several phases. The first phase is concerned with the development of an "executive routine" (a hierarchical set of directions the learner is to follow). The steps in the routine become more automatic with repeated practice and appropriate feedback. Typically, presentation of psychomotor instruction is enhanced by some form of visual representation for the learner. These instructional strategies should carefully group meaningful and related parts of the skill. Research has shown that the learner can benefit from mentally practicing the skill before actually physically engaging in it. Actual practice should be repetitious and immediate feedback is essential. Some complex skills may be assisted with the use of a job-aid as long as the learner is instructed in its use. The ultimate evaluation of these skills rests on whether or not the learner can perform the task. Transfer of psychomotor skills will be facilitated when testing is matched with the learning context.

Instructional strategies for the successful attainment of an *attitude* are grounded in the theoretical belief that human attitudes consist of three basic components: feelings, behaviors, and cognitive understanding. Ideally, presentation of the instruction should be by a "human model" who is respected and admired by the learner. It is also helpful if the learner can see the model being rewarded for the particular attitude being instructed. The substance of the instruction is the teaching of the behavior that is to be demonstrated as an attitude. If negative behaviors already exist, the ID may need to focus the instruction on self-awareness and teach alternative behaviors for the situation. Instructional strategies that may be employed are: simulations, videotaped behaviors, group discussions of how peers judged learner behaviors, or scheduled observation of a person who carries a positive reaction for the learner in a critical situation. Practice must include opportunities to choose followed by consistent rewards/consequences to help ensure that the appropriate behavior becomes associated with the given response. There is some evidence which suggests that attitudes can be learned vicariously, so mental rehearsals may prove beneficial for practice. Follow-through activities may include additional instruction, a review of the directness and relevance of the rewards, and whether unpleasant consequences might be effective.

This author believes that it is through a blend of cognitive theory and a systems approach to instructional design that the most effective learning situations can be offered to the learner. The variables are many and the designs complex, but contemporary research continues to reveal bits of the mystery that surrounds how and why humans learn. It is the application of these tiny bits of the theoretical puzzle that fascinates instructional designers and allows them the opportunity to advance instructional methodology to meet learner needs.

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Cognitive science: A new foundation for teacher education

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Never in history has the American educational establishment come under such harsh criticism. The term A Nation at Risk (Gardner, 1983), which aptly describes the potential result of a decline in the nation's educational system, has become part of the common vernacular. Justifiably, colleges of education have borne the brunt of much of this criticism, even to the point of being called the graves of academe (Mitchell, 1981). State after state has experimented with alternative certification, thus challenging the very need for professional education. It has become apparent that educational foundations, once the core of professional education, has become irrelevant in today's information-rich and technological environment. There are at least two problems with the traditional approach to educational foundations.

The first problem is that the approach has not changed much since the turn of the century. Our students, living in a world of information and technology, have little patience with this antiquated curriculum. It is interesting to note that while foundations faculty believe they are presenting students with the cornerstones upon which the field of education is built, the students perceive the courses as nearly totally irrelevant.

The second problem with the traditional approach is that the separate disciplines that encompass educational foundations bear little relationship to each other. A foundations department might consist of educational philosophers, historians, psychologists, sociologists, and others. It is difficult to argue that these separate disciplines belong together. Because of these problems, many colleges of education around the country have done away with their foundations departments. We believe that this is an unfortunate solution to the problem. We believe that the foundations of education must be reinvented rather than be abandoned. This reinventing must be focused on the answers to one simple question. How do humans learn? This is the foundation upon which we must rebuild.

Recently, significant advances have been made in the attempt to understand human learning. These advances are so significant that they have resulted in the emergence of a new science called cognitive science. This new science is unified by two principles. First is the quest for knowledge about cognition and learning. Second is the belief that computers are a useful tool for learning about cognition. We propose that the new foundations of education must be based on the latest findings in this important field.

What is Cognitive Science?

Cognitive science is an interdisciplinary science that provides the historical, philosophical, and cultural contexts that we believe should form the foundations of education. Cognitive science is based upon research in the fields of philosophy, psychology, artificial intelligence, neuroscience, computer science, anthropology, linguistics, information science and complexity. According to Gardner (1987) Cognitive science is

> ... a contemporary, empirically based effort to answer long standing epistemological questions—particularly those concerned with the nature of knowledge, its components, its courses, its development, and its deployment.

From this definition, it is clear that cognitive science deals with the topics that are at the heart of what teacher education should be all about, the study of human learning. These historical, philosophical, psychological, physiological, mathematical and cultural aspects of cognitive science should be the new foundations for teacher education.

Historical Perspective

Although Cognitive Science has only been formally recognized as an academic discipline for little more than twenty years, it traces its philosophical origins back to the ancient Greeks. Platonic dialogue and the Socratic method explored the nature of knowledge, its origins, its structure and its representations in the human mind. Aristotelian thought, the principle cornerstone of the Middle Ages, governed the theologian's discussions about knowledge.

Beginning with the Renaissance, the empirical sciences attempted to answer these critical questions using the scientific method. Descartes, Kant, Locke and others helped form the basis of modern western notions about cognition. In fact, during the Enlightenment Giambattista Vico even named this endeavor *Scienza Nova* (New Science) to accommodate the new way of thinking about knowledge (Gardner, 1987).

Today's cognitive scientists, like their counterparts of ancient times, ask the same questions and search for the same knowledge. However, they come armed with a bewildering array of technological tools unimaginable just twenty- five years ago. The basic research tool of the cognitive scientist is the computer, which is used to test hypotheses about how the human mind works. Computers and what they will teach us about cognition are destined to form the foundation of a new education science for the 21st century. Thus, to be effective in the information age, teachers must know in depth the answers to such questions as: What does it mean to know something? What are the sources of knowledge? How do we represent knowledge? What is information? How is it stored, retrieved and transmitted? How might it be lost? What is its economic worth? What is the nature of individual differences? What is a form, an image, a concept, a word, an idea? How do modes- of representation relate to each other? Why do we want to learn? What are the constraints on knowing? What are the limits of human learning, and what technological tools can we use to facilitate learning?

Cognitive scientists are attempting to apply modern scientific methods to answer some of these great epistemological questions. They are not only just revisiting these questions, but are also applying new empirical methods using such new disciplines such as artificial intelligence. Artificial intelligence is a branch of computer science and cognitive psychology that is concerned with such deep questions as "what does it mean to say that a machine can think." This question is the twenty-first century version of the ancient Greek philosophical questions. Thus, this modern day *Scienza Nova*, with its ancient origins, promises to yield untold intellectual riches to a new generation of Americans.

Features of Cognitive Science

Cognitive science is truly an interdisciplinary approach to studying learning and cognition. As diverse as the fields that contribute to Cognitive science are, there are several beliefs that unite them. Cognitive scientists believe that to explain learning one must deal with how knowledge is represented in the brain. In positing this representational level, cognitive scientists are free to look at the use of symbols, ideas, schemas, and other abstractions. Cognitive scientists believe in the importance of using computers to represent aspects of these abstractions. This is rooted in the belief that the computer is a good model of at least some aspects of human thinking. Therefore, the computer serves as a way to test research hypotheses about cognitive processes.

From Smokestacks to Computer Chips

The world is rapidly changing from an industrial-based society to an information-based society where information is increasingly valued as a major currency of worth. Today, we are witnessing a dramatic change in the method of producing goods. Cheap and reliable robotic technology is taking more of the place of human labor, thus reducing a major production cost. As we move toward the 21st Century, the major cost of production will not be labor, as it is in a smokestack industry, but information. The ideas, the creativity and the intelligence needed to produce advanced products will be of the highest value. Information exists in many forms and exhibits characteristics that the average citizen of an industrial society do not understand.

Information must be processed and acted upon by either computer chips or organic neurons. We engineer computer software to act upon this information so that our genetically engineered wetware can act upon it. We can generate, measure, manipulate, reconfigure and mold information into a product that has intrinsic value, just as we do with steel in a smokestack industry. As such, processed information acquires a value that transcends its electrical representation. However, the similarity between information and a manufactured product is only transitory. Unlike manufactured products information, once manufactured, can exist in more than one place at a time. It can be reconfigured and given additional value. In fact, it has an infinite quantity and limitless potential value.

As an academic discipline primarily engaged in the processing and transmission of information, teacher education has the obligation not only to manufacture new information, but also to explore, discover, and explain the historical, philosophical, psychological, technological, and cultural aspects of those factors as they relate to cognition. This will prepare teachers to contribute to an information based society. This is the job of cognitive science. It must be part of any 21st Century educational enterprise. To ignore it in the teacher education curriculum is to deny both our historical origins and our future as scholars in a 21st century society.

Implications for Education

The time has come for educators to view their field as a science. Fortunately, the interdisciplinary field of cognitive science seems to provide an excellent fit. With its emphasis on mental representations and the use of the computer to understand the mind and learning, cognitive science provides both a foundation for potential teachers and a research paradigm for university faculty. It is time to transform teacher training to teacher education. This education must be based upon the most current knowledge about learning. If schools of education fail to transform themselves from an industrial based enterprise to an information based academic discipline, they may be doomed to extinction. Education must take its rightful place among the other cognitive sciences.

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RESEARCH Section 1

Introduction

The research papers submitted to this year's annual demonstrate an ever-widening knowledge base linking teacher education and technology. The papers presented in this section have been organized around three subcategories of research: (1) collaboration in linking technology and education, (2) computers in K-12 school curricula, and (3) preservice teacher attitudes and skill acquisition.

Collaboration in linking technology and education

The first article in this section, *A SASSI Partnership: Educator/Librarian Collaboration to Promote Information Literacy*, by Slaughter and Knupp (Indiana University of Pennsylvania), reports on an interdisciplinary alliance between education and library sciences to enable students to develop transferable skills in the process of research, and reading and interpreting literature in any field of education.

Barron and Ivers (University of South Florida) describe a collaboration between telecommunications and education in their paper, *Eliminating "TeleConfusion": Telecommunication Training Materials for Teacher Education.* This paper describes a recently funded development project by the Florida Department of Education and the Florida Information Resource Network to provide telecommunications training materials for teachers.

Computers in K-12 curricula

The purpose of a study by Bauder and Mullick (State University of New York Institute of Technology at Utica/Rome) was to examine factors related to technological change. Their article, *Computers in K-12 Schools: Conditions related to Adoption and Implementation*, focuses on the conditions that best predict implementation of computers into elementary and secondary curricula.

Teacher attitudes and skill acquisition

Students' Thoughts and Feelings during Technology Skills and Concepts Acquisition, by Hunt and Bohlin (California State University, Fresno) reports on a study designed to gain insight into students' thoughts and feelings and, thereby, identify specific classroom events and teaching practices which promoted positive changes.

In *Developing the Computer-Competent Preservice Teacher*, by Petrakis (University of Nebraska-Lincoln), describes an initiative by the faculty at the University of Nebraska-Lincoln Teachers College to develop the computer competence needed for preservice teachers to successfully integrate these skills into their teaching.

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A SAASI partnership: Educator/librarian collaboration to promote information literacy

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Introduction

"It is extremely ironic that people living in the information age feel more, rather than less, ignorant."

(Halal, 1992, p. 15)

In our respective roles as social studies educator and university librarian, we are particularly concerned with the essential competencies of the democratic citizen living in the United States and in the global village. Having agreed that information literacy and information competency (see Kaufman, 1992) are essential to the social studies, our intention is to foster these skills in social studies education. To implement this intention, we formed an interdisciplinary alliance between education and library sciences to address the information needs for U.S. and global citizenship education. Our partnership specifically established learning goals for college students enrolled in a graduate social studies education course titled "Recent Trends in Social Studies." We have called our collaboration a "SAASI" partnership, reflecting the information literacy abilities to Structure, Acquire, Analyze, and Synthesize Information. In creating this partnership, we provide essential practice in research skills for elementary education majors no matter what their previous library experiences. Our collaborative efforts are designed to enable participants in a social studies course to generate new knowledge and evaluate the results of their individual and collective efforts.

Much of the motivation for our partnership was derived from the report of the American Library Association Presidential Committee on Information Literacy (1989). It very clearly outlines the need for information literacy in today's society and gives concrete recommendations for encouraging the development of information literacy skills. Our SAASI partnership was formed to adopt the report's recommendation number 5 : "Teacher education and performance expectations should be modified to include information literacy concerns" (p.13).

Although this particular partnership deals with social studies, the structural format and collaboration could be utilized with any content area. This collaborative effect should enable students to develop transferable skills in the process of research, and reading and interpreting literature in any field of education.

Background

The Setting. Indiana University of Pennsylvania (IUP) is a comprehensive regional university in western Pennsylvania with a broad range of undergraduate, masters and doctoral level programs. Starting as a normal school in 1875, IUP has grown to approximately, 14,000 students. In Pennsylvania, IUP is the second largest institution that prepares teachers. The major education programs, Early Childhood and Elementary Education, are housed in The Professional Studies in Education department which has the largest number of students of any department on campus.The IUP Libraries reflect the teacher training tradition of the institution by collecting extensively in education materials, including multimedia materials. The Libraries have also adopted new technologies, such as an on-line catalog, CD-ROM databases, etc., to access these resources.

Information Literacy. In a discussion of various definitions of information literacy, Demo (1986) observed that information literacy implies process skills and their development requires not only "exposure to information and the instruments of access and delivery" (p.8), but also the ability to evaluate information for problem solving or decision making. Breivik (1991) states that "today's definition of literacy must include not just the ability to read, but also the ability to find and evaluate needed information so that the reader can function and work as a productive member of society" (p. 29). Horton (1983) views information literacy as involving awareness of the knowledge explosion and understanding how computers "can help identify, access, and obtain data, documents and literature needed for problem solving and decision making" (p. 16). Additionally, Snavely (1992) emphasized the importance of the research process as a major component of information literacy.

From these viewpoints of information literacy, we designed our collaborative efforts to enable participants in the social studies course to employ current technology in their quest for information and ideas. Using SAASI as the framework, we established performance expectations at two levels: (1) The course—We set expectations that graduate students researching an area of interest are able to Structure, Acquire, Analyze, and Synthesize Information in the area of social studies education; and (2) The individual—We set expectations that each student become a more enlightened citizen and be able to find his or her own information, not only for this course, but also for "a lifetime of learning beyond the classroom" (Snavely, 1992, p. 4).

The SAASI Partnership : Structure, Acquire, Analyze, and Synthesize Information

Social Studies, as citizenship education, is essentially concerned with interaction between and within various elements of man's social environment and the effects of these interactions. Because of the rapid explosion of information in our society today, and the process of globalization, social studies goals must address the information needs for citizenship in the "information age."

Goals

Our partnership is designed to achieve four major instructional goals:

1. Participants would acquire new approaches to research and acquire information literacy skills. Students would refine information seeking behaviors they had already acquired and adopt new skills to round out their proficiencies.
2. Participants would realize the relevance of information literacy as an essential skill to their own continuing education.
3. Participants would build information literacy teaching skills and begin to explore possibilities for incorporating these skills into their own teaching.
4. Participants would advocate the value of information literacy throughout their professional careers.

Communication Process

The process of communication most suitable in our setting entailed an informal, horizontal communication between the Professional Studies in Education and the University Libraries and Media Resources departments. The basic elements of our SAASI strategy were: 1) meeting to share the specific library exercises designed for the class including the value in the total course grade; 2) collaborating on the process and content for teaching informational literacy skills; 3) determining when and where in the course is most suitable to conduct a library presentation that includes hands-on learning experiences for the group; 4) collaborating on product evaluation criteria; and 5) articulating a commitment to provide individualized instruction following the evaluation of each student's first library assignment.

Structure. In the setting of the University Libraries, the librarian's presentation exposed the college students to meaningful information about the organization of library materials and provided examples of how to utilize that structure for finding relevant information. Some of the new concepts included in the presentation were: controlled vocabulary searching, logical operators (AND, OR, NOT), and free text searching. Class discussion focused on the presentation of the ERIC Thesaurus and the Library of Congress Subject Headings. The whole class was introduced to the library's on-line catalog and the CD-ROM ERIC database, through demonstration.

Acquire. The first library exercise required each student to engage in a search strategy that would yield as many journal articles as were available that related to his or her research topic. Students were encouraged to utilize both print and CD-ROM databases to fulfill this segment of the library assignment.

Analyze. As a result of searching several preliminary sources (Current Index to Journals in Education, Resources in Education, or ERIC on CD-ROM) the students were to select two sources that were most likely to be productive for the special problem or area of interest. The next step required a review of the social studies literature to decide about the degree of importance of the journal article to the student's research topic. An important skill in this phase is the ability to evaluate and classify information. As each article was identified, the student was in effect asking the question, "Is this article relevant to my topic?" Having decided on the importance of an article, the next step was to categorize his/her findings under the headings *Minor importance to the topic*, *Moderate importance to the topic* , or *Most important to the topic*.

Synthesize Information. The synthesis process required that each student, as researcher, determine whether a common thread existed within each of the articles and identify a trend. Through the synthesis process, the students were able to integrate newly discovered information and their own experiences to form a new knowledge base.

Assessment Criteria

Collaboratively, we established specific criteria to evaluate the results of the students' search strategies. Each student was required to submit a written synopsis of his or her findings for each of the three categories. From our perspective, the ability to satisfactorily summarize and classify the journal articles and to identify trends were of primary importance for evaluation. Other criteria included evidence of skill in using research tools and in the mechanics of preparing a bibliography.

Follow-up Instruction

The initial evaluation of the students' work revealed a small number who did not complete the exercise satisfactorily. Our expectation for the exercise was that all students master the information literacy skills vital to the success of the assignment. Accordingly, this small group of students were given the opportunity to meet individually with both the course instructor and the librarian to reinforce the learning and to redo the assignment. The shortcoming in all of these cases was that the student did not sufficiently narrow his or her topic to adequately attack the proposed problem. Through consultation, these students were able to refocus their efforts and, subsequently, complete the project satisfactorily.

Student Impact and Reactions

We were able to assess the impact of SAASI by reviewing the finished library exercises. As a group, the class performed competently. We observed that, because each student was allowed to select an issue or topic of interest for research, a high level of mastery of social studies knowledge was attained. We also observed that students were able to increase their proficiency in information literacy skills. They also recognized the value of these skills in their lives. The following anecdotal data, reported by students who participated in the course, reinforce our impressions from evaluating the students' work:

> Through my own research, which I have learned to fine tune, I learned about integrating literature in social studies and other content areas. I have developed an understanding of what it means to be globally aware and I think about such topics as keeping the arts alive in our public schools.
>
> I learned there is a great deal of current research that shows effective methods for teaching social studies.
>
> I learned to use better the ERIC system in the library, and to read, read, and read articles and reform reports to continue to be current in any discipline.
>
> I learned research procedures concerning issues and trends in social studies through evaluation of social studies priorities in elementary grades. Through exploration of specific problems of interest, and various activities, different modes of inquiry were experienced for continued pursuit of knowledge in various areas of thought.

Reflections

At our university, the SAASI Partnership, as we have experienced it, is a beginning. We are continuing to develop and refine the instructional process using the data from our initial implementation of SAASI. Since we have taken these initial steps, the Association of College and Research Libraries (ACRL), Education and Behavioral Sciences Section (EBSS) has published new guidelines for information retrieval and evaluation skills for education students (1992). Our analysis of this document affirms that our partnership provides a needed component in the educational process. We have concluded that the students who enrolled in "Recent Trends in Social Studies" are better equipped to manage information in the rapidly changing world. However, we recognize the need for additional research into further impacts of information literacy education. Have we been successful in fostering a true appreciation of the benefits of information literacy to our students? Will the future teachers in our course be able to translate their knowledge and information literacy skills in the classroom? Overall, we were gratified by our students' accomplishments through our SAASI Partnership. In future implementations of SAASI, we would be in a position to evaluate the true impact of this collaborative process.

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Eliminating "teleconfusion": Telecommunication training materials for teacher education

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Introduction: A Scenario

At long last! Mr. Cronbach had just received a modem through a mini-grant he had written entitled "A Classroom Without Walls." He had heard several of his colleagues speak of the wonderful potential of telecommunications—students exchanging data and activities with students in other countries, access to online database systems, information interchanges through online conferences, sharing ideas with other teachers. Mr. Cronbach tore the modem out of its box! It came with a manual, a power supply, a telephone line, and a cable to attach the modem to his computer. Thumbing through the manual and referring back to his computer's user's guide, he got everything connected and plugged the phone line into the phone jack the principal had installed in his classroom.

Now, the moment he had been waiting for: He booted up his communications software, clicked on "dial," typed in the local bulletin board system (BBS) dial-up number, and clicked "Ok." Silence. Nothing appeared on the screen. Mr. Cronbach waited a few more seconds and tried "Redial." Again, nothing. Something was definitely wrong. He checked his modem connections, but they were fine. He opened his software manual and began reading. Parameters? Handshake? Stop Bits? Parity? Emulation? Port? He read further and realized he needed some information about the local BBS. He got his account information and found the listing of possible settings, all of which varied depending on the communication software being used. Things were getting a little more complicated than Mr. Cronbach had anticipated. He had always heard that telecommunications was just like talking over the phone lines. This was beginning to be a little more complex than plugging in a telephone.

Mr. Cronbach went back into his software's setting section and made some choices based on the information he had read. He clicked on "Redial." This time he heard dialing tones, followed by a static sound. Garbled letters began racing across his screen. He pressed Return; more garbled letters appeared. He clicked on "Hang-up," and felt his blood pressure rising. He decided to edit his software's setting section. He changed the emulation, data bits, and parity. He clicked on "Redial." Again, Mr. Cronbach heard dialing tones, followed by a static sound. Words appeared on the screen! Mr. Cronbach sighed with relief. Whatever he had done, it obviously worked. The words said, "Please log in." Mr. Cronbach entered his name and pressed Return. An error message appeared. The computer screen stared back at him, "Please log in." He knew he had received a username for the BBS, so he tried that instead. An error message appeared. The computer screen stared back at him, "Please log in." Mr. Cronbach had no idea what "Please log in" meant. He looked back at his BBS reference guide and found the directions for the information he needed to type. (Perhaps, he thought, something he should have done in the first place.) In his haste to proceed, he incorrectly typed the log in command. When he went back to delete the characters, his delete key wouldn't move the cursor! He pressed Return to start again. Instead of the regular error message, the system came back with the message, "Please contact your local sysop" and disconnected him.

Mr. Cronbach looked over to his modem and began thinking about its potential as a paper weight. He would try one last time. He clicked on "Redial." Dial tones and static sound pierced his ears. The "Please log in" prompt appeared. Slowly and carefully, Mr. Cronbach entered the log in information. The screen scrolled. Mr. Cronbach sighed. It now asked for his Username. Slowly and carefully, he typed in his username from his BBS information guide. The screen scrolled. Next, the system asked for his password. Slowly and carefully, he typed in his password from his BBS information guide. The screen scrolled. He was welcomed to the BBS. To make a choice on what he wanted to do, all he had to do was type the command and press the GOLD key on his keyboard. Mr. Cronbach looked. None of his keys were gold.

* * * * *

The frustration and confusion that teachers may experience when first learning about telecommunications is an unnecessary obstacle to providing students "classrooms without walls." Unfortunately, lack of teacher training and support continues to be a challenge for technological advancements in many schools. To make telecommunications a less frustrating and confusing experience for Florida educators, the Florida Department of Education, Bureau of Educational Technology, and the Florida Information Resource Network (FIRN) have provided funding for training materials. The components of these materials are described in this paper.

Background

Several years ago, FIRN was established by the Florida Legislature through the Department of Education. This wide-area telecommunications network was primarily used to connect data centers and computer resources at universities, community colleges, and school districts. For example, school districts could access the system to transmit attendance records to the state office in Tallahassee.

In 1991, the electronic mail component of the system (FIRNMAIL) was expanded to provide free use for all public educators. Teachers and students now can retrieve information from remote databases at the state universities, including the online library catalogs and ERIC (Educational Resources Information Center). They can also download a weekly teacher's guide to NewsWeek or image files of satellite weather. In addition, through FIRNMAIL, educators can send and receive messages to other educators throughout the state and participate in conferences of common interests.

To meet the needs of FIRN users, there are ten technical support personnel (FIRNTECs) located at various sites throughout the state. Using telephones or electronic mail, the FIRNTECs provide assistance on hardware and software issues. They also conduct training sessions for teachers and administrators.

The FIRNTECs have been extremely successful in meeting the technical needs of the network. They do not, however, have the time to produce the range of instructional materials required by new FIRN users. For that reason, the Florida Center of Instructional Technology (FCIT), one of four "satellite" centers funded by the Florida Department of Education to assist educators, was asked to design and develop a variety of products, including a booklet on telecommunications basics, computer tutorial/simulations, and brochures.

Booklet on Telecommunication Basics

Telecommunications vocabulary, such as parity, half-duplex, and terminal emulation, are almost a "foreign" language to many educators. In addition, it can be frustrating for novices in the field to determine which modem to buy, how to connect it, and how to ensure the proper software settings. To provide guidance for teachers, a booklet entitled *Telecommunications Basics* was written. The booklet is composed of four main sections, including:

1. Educational Applications for Telecommunications. This section outlines several advantages provided by utilizing telecommunications in educational environments. Broad areas, such as "access to experts," are expanded with short case studies of actual implementations.

2. Hardware. The hardware section provides procedures for selecting and installing the hardware components. Detailed graphics are provided to illustrate the configurations required to connect a modem to an Apple IIe, Apple GS, Macintosh, and MS-DOS computer.

3. Software. In the software section of the booklet, educators are introduced to the concepts and settings required for baud rates, stop bits, terminal emulation, and other parameters. Sample telecommunication software programs are referenced as examples of communication settings.

4. Commercial Systems. The final portion of *Telecom-*

munications Basics is devoted to commercial systems for telecommunications. A brief description of each system is included, as well as contact information.

The booklet also includes several appendices, including a generous glossary of terminology, a list of technical support personnel, and dial-up numbers for local access to the state network.

Computer Tutorial/Simulation

Florida provides a free electronic mail system (FIRNMAIL) for educators. Although it is primarily a menu-driven system, new users often need help with the interface. For example, the software was originally developed for a VAX mainframe and several of the commands refer to a "Gold" key. There is no "Gold" key designated on microcomputers, and users can easily become frustrated looking for one.

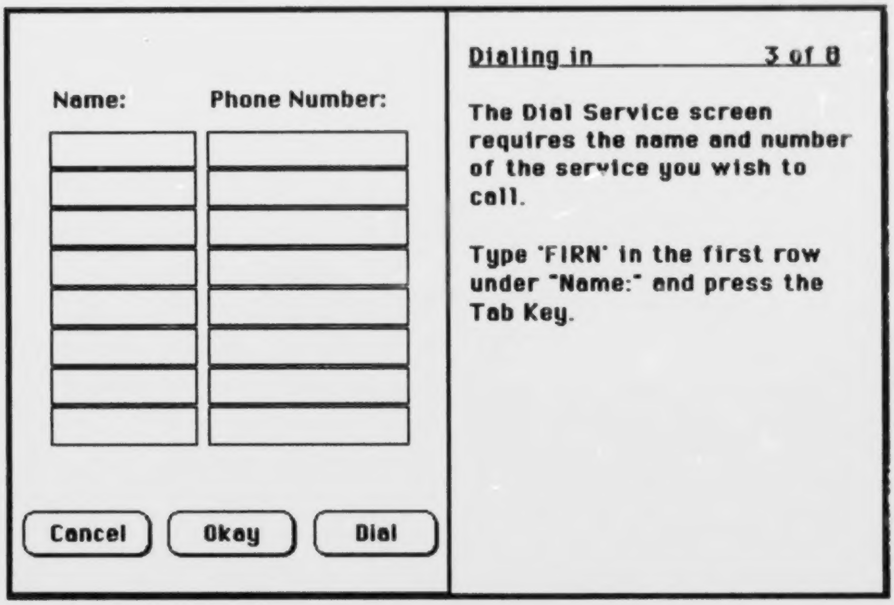
Another feature of the FIRNMAIL software that can cause confusion is the concept of the electronic folders. Each user automatically has five folders (Inbox, Outbox, Created, Read, and Wastebasket). Knowledge of these folders is important for users to find, retrieve, and delete their messages.

In order to provide a means by which educators can familiarize themselves with FIRNMAIL, a computer simulation was developed. This program enables users to practice creating and sending messages without obtaining a FIRNMAIL account, a modem, or a telephone line.

The computer program was designed with four major categories. Each category is a Main Menu selection that can be accessed in any order, or repeated, if desired. Throughout the program, maximum learner control is provided with permanent options such as Review, Return to Menu, and Exit. In addition, users can access a course map to determine their location or navigate through the program. A glossary of terms is permanently available also. The program contains the following sections:

1. Telecommunications Basics. The first section of the program provides introductory information on telecommunications. Configuration requirements are outlined and illustrations are provided for connecting modems to various computer types. In addition, communication software settings are defined with a simulated screen. Students also interact with the program to enter dialing instructions in the software (see Figure 1).

2. Introduction to FIRNMAIL. The second portion of the lesson focuses on FIRN and FIRNMAIL. After providing background information, the program introduces the concept of electronic folders for storing messages. In order to make the abstract concept of

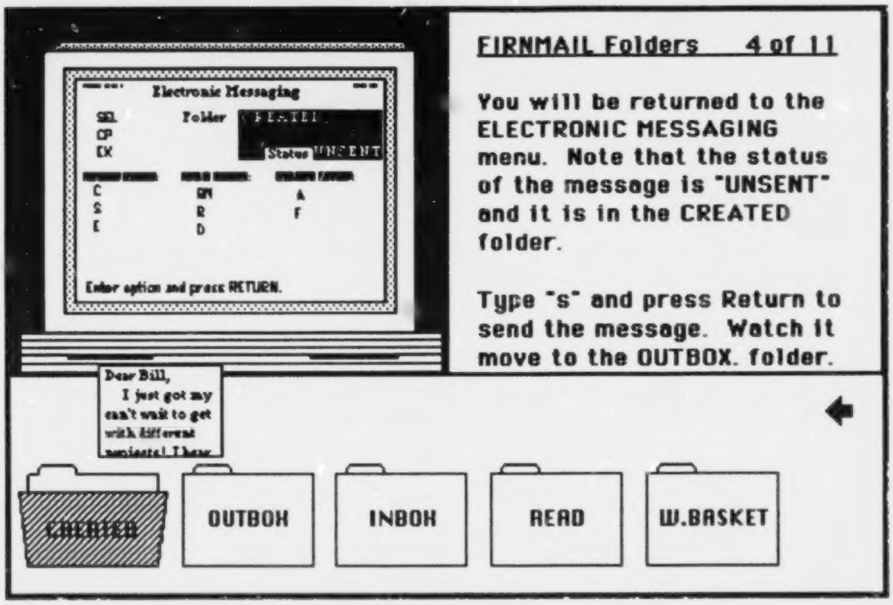


Dialing in 3 of 8

The Dial Service screen requires the name and number of the service you wish to call.

Type 'FIRN' in the first row under "Name:" and press the Tab Key.

Figure 1. Sample dial-up screen.



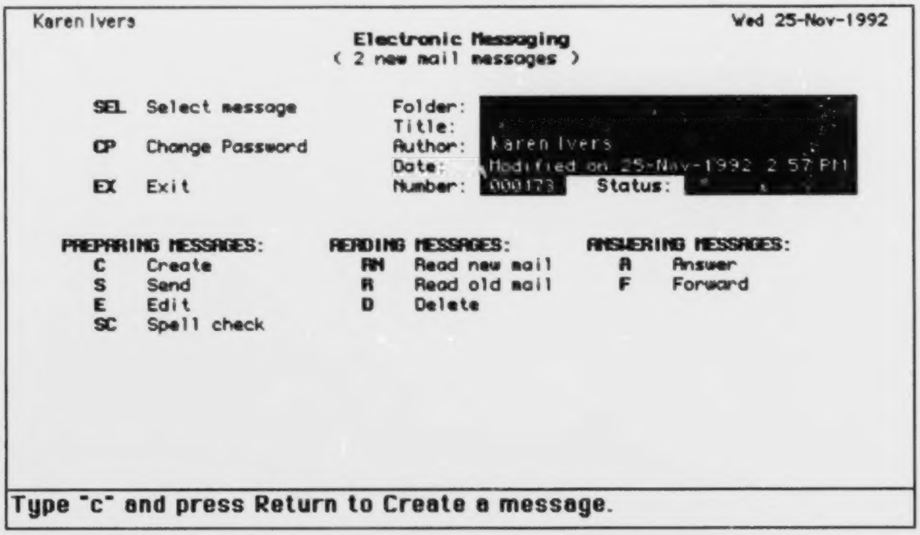
FIRNMAIL Folders 4 of 11

You will be returned to the ELECTRONIC MESSAGING menu. Note that the status of the message is "UNSENT" and it is in the CREATED folder.

Type "s" and press Return to send the message. Watch it move to the OUTBOX. folder.

Electronic Messaging
SEL
CP
EX
Folder
Status UNSENT
C
S
E
RN
R
D
A
F
Enter option and press RETURN.
Dear Bill,
I just got my
can't wait to get
with different
projects! I hear
CREATED
OUTBOX
INBOX
READ
W.BASKET

Figure 2. Animated message folders.



```
Karen Ivers                                                    Wed 25-Nov-1992
                              Electronic Messaging
                           ( 2 new mail messages )

     SEL  Select message            Folder:
                                    Title:
     CP   Change Password           Author:  Karen Ivers
                                    Date:    Modified on 25-Nov-1992 2 57 PM
     EX   Exit                      Number:  000173    Status:

   PREPARING MESSAGES:         READING MESSAGES:         ANSWERING MESSAGES:
     C    Create                 RN   Read new mail        A    Answer
     S    Send                   R    Read old mail        F    Forward
     E    Edit                   D    Delete
     SC   Spell check

Type "c" and press Return to Create a message.
```

Figure 3. Captured system screen.

folders more concrete for the users, the program includes animations depicting the movement of messages from folder to folder (see Figure 2).

3. FIRNMAIL Simulation. The third segment contains a detailed simulation of FIRNMAIL. Students can emulate the exact keystrokes and procedures required to create, send, read, index, and delete messages (see Figure 3). The lesson is very realistic and uses the student's name to produce a FIRNMAIL identification name similar to that of the FIRNMAIL system.

4. Applications. The final section of the courseware provides information on applications. A list of the names and focus areas of several commercial applications is included. The address and telephone number of the vendors are also provided for those seeking further information (see Figure 4). Similar information is included for applications that are specific to Florida and FIRN.

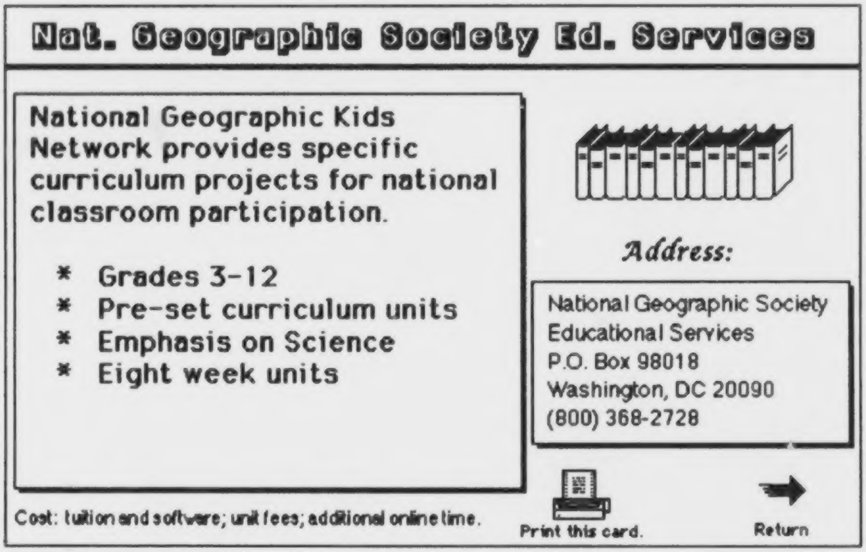
Brochures for Electronic Access

In addition to FIRNMAIL, Florida's educators can access several other electronic databases through FIRN. These systems are free of charge and are available through local dial-up access numbers. The systems include:

- LUIS (Library User Information System). LUIS is the online card catalog system of library materials found within Florida's State University System.
- ERIC (Educational Resource Information Center). ERIC is a large database of educational journals and reference materials.
- FCIDS (Florida Curriculum Information Database System). This application provides information for teachers and guidance counselors in Florida.
- Free for Teachers Database. This database is an automated clearinghouse of Florida-based programs, materials, and other environmental education information.

The database systems are housed at various mainframe computers throughout the state and do not have standardized interfaces. For example, FCIDS uses an IBM mainframe and users must emulate PF keys for commands. FREE for Teachers requires users to communicate with KP (keypad) commands, and FIRNMAIL utilizes GOLD keys.

In addition to the confusion caused by the non-standardized interfaces, each system has a very different and unique log-on and log-off procedure. To provide some guidance for users and to enhance the use of these systems, quick reference guides and brochures were developed for each application. The quick reference guides provide clear and concise procedures for accessing



Nat. Geographic Society Ed. Services

National Geographic Kids Network provides specific curriculum projects for national classroom participation.

- Grades 3-12
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- Emphasis on Science
- Eight week units

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P.O. Box 98018
Washington, DC 20090
(800) 368-2728

Cost: tuition and software; unit fees; additional online time.

Figure 4. Sample commercial application screen.

and exiting the systems. They are produced on card stock and connected with a ring for ease of use.

The brochures expand on the quick reference guides and provide additional information on the use of the systems. Substitution keystroke commands for terminal emulation, sample searches, and dial-up access numbers are outlined in the brochures.

Conclusion

The booklet, brochures, and simulation are being used to encourage and enhance the use of telecommunications and FIRNMAIL in Florida. Through these products, teachers can obtain information and practice in the basics of telecommunications. Florida now has additional materials to help teachers explore telecommunications and become "TeleConfident."

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Computers in K-12 schools: Conditions related to adoption and implementation

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Introduction

Why have computers not become the promised indispensable classroom instructional tool? Why is it that only a few teachers have accepted the use of the computer as part of their instructional activities, while others ignore it altogether or relegate it to a corner of the classroom for infrequent use by select students? In some schools, computer use is carefully planned and integrated into the curriculum; in others, computers are the focus of a separate curriculum; while in many, computer use is as varied as the teachers themselves (OTA, 1988). The present study investigates factors that facilitate or hinder integration of the computer as an instructional tool throughout the primary and secondary educational system.

Background

Two general spheres of inquiry were found to be relevant to the study. These included research on change in general and on more narrowly defined technological change in education.

Research on change has focused on several different aspects that may affect the degree of adoption, implementation, or institutionalization of an innovation. A sample of these dimensions follow.

Reasons for change:

Projects adopted for opportunistic reasons are less likely to have the support and commitment of local participants than those in which the project represented a response to problem solving in the district (Berman & McLaughlin, 1975).

Structure of the system:

Both the structure of the individual district and the larger educational system are important factors in the diffusion of educational innovations. Few incentives encourage individuals to counter existing organizational patterns and practices (House, 1976; Rogers & Agarwala-Rogers, 1976).

Organizational and individual concerns:

Individual behaviors are a function of individual and organizational factors such as interpersonal relationships, institutional goals, and participative planning (Buchanan, 1969; House, 1976). Individual concerns of the user form a key component to the Concerns-Based Adoption Model (CBAM) (Hall & Hord, 1987).

Fidelity to the innovation:

To what degree is an innovation that has been modified still the innovation planned? Studies that confirm or deny successful results of innovative programs must first verify what is being studied (Berman & McLaughlin, 1975; Hillson & Hyman, 1971; Hall & Hord, 1987).

Personal characteristics:

Although organizational structure and goals and personal concerns must be considered, personal characteristics also play an important role in the acceptance of innovation (Watson, 1969; Klein, 1969; Knupfer, 1990). Change agents must be prepared to adapt to the different personality types of both early adopters and resistors.

Systemic conditions:

This perspective includes aspects of each of the above dimensions within the system, rather than being a separate dimension. Models that incorporate a systemic view also acknowledge the interaction of components within the system (Ely, 1990; Berman & Pauly, 1975).

Although each approach for examining dimensions of change has a different focus, there is considerable overlap in the categorizations and some models incorporate the best features of others.

Studies of computer use in schools have been concerned with issues of effectiveness (Kulik & Kulik, 1991) or with aspects of implementation such as student/computer ratios, types of hardware and software, or policies concerning computer use in schools (Bruder, 1988; 1989; Goodspeed, 1988). Other literature deals with attitudes toward computers or preservice and inservice training issues (Carey, Carey, Willis & Willis, 1991; 1992).

Few studies have taken a more systemic view of factors that may be related to implementation of computers in schools (Winkler & Stasz, 1985; Plomp, Pelgrum & Steerneman, 1990). In these studies, surveys identifying factors to facilitate or hinder computer use were restricted to either computer-using teachers or technologically advanced schools. These studies therefore failed to obtain viewpoints of both computer users and non-users in a broad range of schools and settings.

Drawing upon the literature and personal experience as a change facilitator, Ely (1990) proposed a list of eight conditions that facilitate the implementation of technological innovations:

1) dissatisfaction with the status quo:
   There must be a reason for members of the system to want to change, either unhappiness with current methods or outcomes or at least an openness to change.
2) knowledge and skills exist:
   The end users of the innovation must have the ability to implement it or there must be provisions within the system for training.
3) resources are available:
   Appropriate and sufficient resources to support the innovation must be available and accessible to end users.
4) time is available:
   Time to learn the innovation, to prepare for its use, and to use it in practice are all necessary for successful implementation.
5) rewards or incentives exist for participation:
   Does the system provide rewards, financial compensation, or recognition that would motivate individuals to participate in the implementation of the innovation?
6) participation is expected and encouraged:
   Participation of all constituencies, especially the end users, in planning, implementation, and evaluation assures a sense of having had a significant impact on the process. Participants therefore have a vested interest in the outcomes of the innovation.
7) commitment by those who are involved:
   Administrators at both the district and building level, as well as those with day-to-day involvement with the program, must support the innovation.
8) leadership is evident:
   Commitment or support alone is not sufficient. Successful programs do not just happen; they are orchestrated. Leadership, too, must be evident at all levels of the system.

Using Ely's (1990) eight conditions as a framework, the present study identified the set of factors which best predict implementation of computers in the instructional process. For this study, instructional computer implementation was defined as the use of computers for teaching or learning but did not include use as a management or productivity tool.

Method

Three hundred twenty-five teachers in twenty-five schools responded to a survey designed to tap estimates of their instructional use of computers and their perceptions of Ely's eight conditions within their schools. Schools that participated in the survey are within a 100 mile radius of Utica, NY and represent a range of grade levels and geographic settings. Both public and private (parochial) schools participated in the study.

Perceptions of the eight conditions were measured by asking teachers to indicate their level of agreement with forty statements, five for each condition. The statements were developed from operational definitions of the eight conditions and related studies. Prior to field testing, content validity was determined by consensus of judgment by experts. Responses were coded on a six point scale with items stated in both positive and negative directions to control for response bias. An estimate of the respondents' perceptions of the presence of each condition, was determined by summing responses to the subscales for that condition.

Although instructional computer use has several facets the questions addressed in this paper are whether teachers use computers and the amount of time computers are used. Teachers were asked if they use computers for instructional purposes. Those who do were asked for an estimate of the number of hours per year computers were used for instruction.

Results and Discussion

Demographics

Seventeen school districts agreed to participate in the survey. Three hundred twenty-five teachers from twenty-five schools responded, with response rates within schools ranging from 10% to 100%. In two schools, the low response rate occurred because only computer-using teachers were asked to fill out the survey. These two schools account for only two percent of the responses.

A wide variety of schools were represented in the study. Grouped according to geographic setting, grade levels, and governance, the number of schools, number of respondents, and percent of respondents in each of these categories can be found in Table 1.

In addition to the school related factors listed above, the following demographic information was obtained: number of years teaching, number of years in the school, tenure status, highest degree earned, number of additional graduate hours, grade level, subject area, age, and gender.

The sample of teachers appeared to be typical of the profession as a whole. Teachers' ages ranged from twenty-two to sixty-four with a mean of forty-two. Seventy-six percent of the teachers were female.

The average number of years in teaching was sixteen while the average number of years teachers had been at their particular school was eleven. Eighty-two percent of the teachers reported having tenure while eight percent were in non-tenure track positions. These findings suggest that teachers in the sample are both experienced and established in their careers.

The analyses indicated that the sample of teachers had strong credentials. All but one percent held degrees. While forty-one percent of the teachers had bachelor's degrees, approximately ninety percent had taken graduate hours. Fifty-eight percent had earned master's degrees or higher.

All grade levels and subject areas were also represented in the study. The distribution of grade level (see Table 1) indicates that forty-four percent of the respondents teach in elementary schools, 13.5% are in middle or junior high schools, and 42.5% are at the high school level. In addition to the traditional academic areas, special education, art, music, physical education, and gifted and talented programs were also included.

Analysis of Conditions Related to Computer Use

Although most teachers (74%) indicated that they do use computers for instruction, more teachers at the elementary level (84%) than at the middle or high school level (59% and 68%, respectively) use computers. Chi-square analyses revealed a significant association between school level and use of computers ($p < .0007$). Comments by teachers suggested that differences in computer usage at different grade levels may be a reflection of more rigid curricula at the higher grade levels or may be related to a perception of inadequate resources for specialized subject areas.

A series of t-tests were performed to determine differences between computer users and non-computer

Table 1
Survey Response by School Characteristics

	# schools	# respondents	% respondents
Setting			
rural	18	242	75
suburban	3	18	6
urban	4	63	19
Building Level			
elementary	13	143	44
middle/jr high	3	44	13.5
high school	9	138	42.5
Governance			
private	2	14	4
public	23	311	96

Table 2
Perceptions of Eight Conditions

N=325	Computer Users	Non-computer Users	*t*	*p*
Dissatisfaction	21.11	21.56	1.19	.237
Knowledge	21.55	14.59	-10.40	.000
Resources	17.75	14.73	-4.13	.000
Time	15.92	12.49	-5.40	.000
Incentives	19.09	17.89	-1.70	.092
Participation	17.61	11.25	-11.08	.000
Commitment	23.74	19.76	-6.94	.000
Leadership	18.39	15.11	-4.84	.000

users in their perceptions of the eight conditions. These results are displayed in Table 2.

Significant differences were found on all but two of the conditions. The small difference in the condition *dissatisfaction with the status quo* is not unexpected. Whether or not teachers use computers, many would like to see changes made to teaching in general and to the use of computers in teaching. A sense of dissatisfaction may stem from frustrations resulting from a lack of other conditions, such as *knowledge and skills*, or *access to resources*.

The second condition that did not achieve statistical significance was *rewards and incentives.* Some incentives have been built into the teaching profession, such as salary increments for graduate or inservice credit. This study measured the degree to which such extrinsic rewards exist. It did not attempt to identify intrinsic rewards.

Two of the largest differences between teachers who do not use computers and those who do was found for *knowledge and skills* and *participation.* Teachers who do not use computers feel that they lack sufficient knowledge and skills to use them in the classroom

(mean$_{\text{non-users}}$ = 14.59 vs. mean$_{\text{users}}$ = 21.55).

The results of the t-tests are supported by examination of the open-ended questions. When teachers who do not use computers were asked why, the most commonly cited reasons were lack of access to hardware (56%), lack of access to software (42%), lack of knowledge (38%), and insufficient time to use computers (35%).

The differences on *participation* shows that this group also is considerably less likely to feel that they are part of the decision-making process with respect to computers than are computer-using teachers

(mean$_{\text{non-users}}$ = 11.25 vs. mean$_{\text{users}}$ = 17.61).

Although perceptions of *participation* were not tapped by the open-ended questions, comments by teachers suggest that they believe that unless they are involved in the decision-making process, they will be excluded from access to resources.

Numbers of teachers who currently use computers is only one indicator of adoption. Another indicator that was considered is amount of time computers are used. Although seventy-four percent of the respondents indicated that they do use computers, when asked to estimate the amount of time, their answers varied from one to over two hundred hours per year.

To examine conditions related to the dimension of time more fully, Pearson product-moment correlations were calculated to investigate interrelationships among the eight conditions and time spent using computers. The values of the correlation coefficients are reported in Table 3.

Consistent with the findings of the t-tests, time using computers was related to *knowledge and skills* (r=.41) and to *participation* (r=.37). Not only was *dissatisfaction with the status quo* not related to computer time, the correlations indicated that even when there was a statistically significant correlation, the amount of variance accounted for by the correlation was low. There were significant relationships among the other seven conditions, however.

Only correlation coefficients of .31 or larger were considered to be of any practical significance. This criterion is commonly used in the literature. Using this criterion, the only pairs of the remaining seven conditions that did not achieve significance were *rewards and incentives* with *participation* (r=.22) and *rewards and incentives* with *knowledge and skills* (r=.25). These results are counter-intuitive to the assumption that the way to increase participation in innovations, and therefore affect knowledge and skills is to offer incentives to teachers. Although beyond the scope of this study, these results suggest that the types of incentives that motivate

Table 3
Correlations between pairs of variables

Variable CT	1	2	3	4	5	6	7	NNNN8
Computer Time	.05	.41**	.29**	.23**	.11	.37**	.29**	.26**
1. Dissat.		.01	.18**	.03	.16*	.06	.19**	.17*
2. Knowledge			.36**	.48**	.25**	.52**	.48**	.40**
3. Resources				.51**	.40**	.40**	.56**	.59**
4. Time					.43**	.46**	.46**	.54**
5. Incentives						.22**	.43**	.46**
6. Participation							.47**	.53**
7. Commitment								.60**
8. Leadership								

*p<.01 **p<.001

Table 4
Stepwise Regression of Conditions Predicting Computer Time

Step	Variable	R	R_2	F-ratio	p
1	Knowledge	.41	.16	60.71	.0000
2	Participation	.45	.20	37.3	.0000
3	Resources	.46	.21	26.82	.0000

teachers should be examined more closely.

A similar pattern of results emerged from a stepwise multiple regression analysis calculated to identify conditions that are the best predictors of time spent on computers. A summary of the regression can be found in Table 4 showing relative contributions of the predictors. *Knowledge and skills* was the single best predictor of computer time, accounting for 16% of the variance. *Participation* and *Resources* were the only other conditions that entered into the MR equation, accounting for an additional 5% of the variance.

Conclusions

While there are clear differences between those teachers who use computers and those who do not, the most striking and obvious factor distinguishing them is *knowledge and skills*. Until teachers become comfortable with computers it is not reasonable to expect them to use them in teaching. What may not be so obvious is the importance of *participation* as a predictor of computer use. *Participation* may be a result of both personal characteristics and organizational structure. Teachers may not participate in decision-making because of their own personal inclinations or because the organization does not afford them the opportunity. Teachers who do not or cannot influence decisions may become disenfranchised and lose interest altogether.

While *availability of resources* also appears to be an important predictor of time spent using computers, it did not weigh as heavily as *knowledge and skills* and *participation*. Because of the strong relationships among *resources*, *leadership*, and *commitment*, it may be difficult to determine which of these conditions plays the most significant role. Further analyses are required to define the interrelationships among these conditions.

One final conclusion that can be drawn from the study is that extrinsic *rewards and incentives* may not be as effective as commonly believed for the implementation of technological innovations. It may be that personal commitment plays a more significant role and that intrinsic rewards and incentives should be considered.

Future research should focus on refinement of the list of possible conditions, their operational definitions, dimensions of computer use, and the interrelationships among them. This type of research should lead to the development of reliable and valid indices for these variables which will enable researchers to develop more comprehensive conceptual models of technological innovation.

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Students' thoughts and feelings during technology skills and concepts acquisition

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Computer Use by K-12 Educators

Just as computers have infiltrated society at large, they have entered K-12 education. The U.S. Congress's Office of Technology Assessment (OTA, 1988) reports that as of 1987, 95% of all American schools used microcomputers in their instructional program; however, only half of all teachers report using computers in their instruction.

Major factors contributing to this incongruous situation are teacher knowledge and attitudes (OTA, 1988, p. 87). Zelman (1986) reported the results of a 1985 survey of over 2 million school teachers by the Corporation of Public Broadcasting in which 31% of the respondents felt uncomfortable using computers and 13% reported avoiding computers.

The authors have extensive experience teaching introductory computer education courses to preservice and inservice teachers. Many students who enter these classes will make verbal statements (e.g. "I dreaded taking this class so much I put it off until the very end of my program") which signal high levels of anxiety. Often this fear is accompanied by negative comments about computers ("I hate computers") and a lack of confidence in their abilities to succeed ("I've never been any good at math or machines").

During the semester, most students will lessen, if not completely eliminate, their previous anxiety and develop more positive attitudes about computers and their ability to use them. By the end of the semester, some of these same students will have convinced themselves that they absolutely must buy a computer for home and school use.

The purpose of this study was to gain insight into students' thoughts and feelings and, thereby, identify specific classroom events and teaching practices which promoted these positive changes.

Design of the Study

The study involved the ninety students enrolled in four sections of a three-unit course titled "Educational Applications of Microcomputers" during the Spring, 1992 semester. Students (68 female and 22 male) ranged in age from 21 to 55. All were either preservice or inservice school teachers.

As thoughts, feelings, and attitudes cannot be observed, journal writing was chosen as the primary means of data collection. Students were required to keep a journal throughout the semester. They were directed to write reflective entries after each class and were given some guidance regarding the nature of the entries and format expected. The journals were gathered approximately four weeks into the semester so that the instructors could give students feedback on their initial work.

At the end of the semester the journals were carefully analyzed for comments which signalled "Ah-ha!"

experiences and meaningful changes in student attitudes and feelings. In order to coordinate responses with classroom events, the comments were organized by time intervals and class topics.

Findings

Classroom events which positively influence student attitudes and feelings were most often tied to the successful completion of an assignment. For example, following the printing of their first wordprocessing document, students made comments such as "I learned something BIG for me—I learned how much faster I can get my term papers done!" "The computer is starting to become my friend," and "[understanding spell check] gave me positive feelings towards computers and has prompted me to agree to a computer for home use." It should be noted that these statements of attitudinal change came very early in the semester— after the second or third class session.

As each topic was presented, attention would turn to K-12 applications. For example, after students had learned to use AppleWork's wordprocessing application, the class would discuss the teaching of writing as a process and how the computer can facilitate writing instruction. After learning the database application, the class would discuss levels of questioning and how databases can be used to promote students' higher order thinking skills. Student comments included, "I can see how wordprocessing would stimulate children to write more" and "I can see the relevance of using databases in my subject area."

Teaching methods relied heavily on a "tell, show, do" sequence. For example, the professor would talk about an aspect of wordprocessing, demonstrate the feature, and have students try it for themselves. Many students indicated that this direct, hands-on approach eased their anxiety. One student wrote, "I have discovered that I learn better if someone demonstrates and shows me."

Other methods included bringing in or referring to non-electronic examples of databases and spreadsheets, reviewing previous learning by having students tell the professor how to complete a sequence, role play and class discussion of ethics and equity issues, and cooperative group assignments. Many students indicated that linking computer concepts to concrete examples increased their understanding. One student wrote, "Introducing databases with index cards helped me understand the basic idea." Others reported,"Using the tactile mode got me to deal with numbers and *nothing* gets me to deal with numbers," and "The role-play activity helped me understand the ethical issues involved in software copyright."

Students liked working in cooperative groups and helping each other. They reported seeing great value in reviewing software in cooperative teams. Several said that having other students help them in class greatly eased their anxiety level. One student proudly wrote, "Helping another student figure out what was wrong [with her Logo procedure] made me feel like a HERO."

Summary

Students appreciated the instructors' intentional low-key, hands-on approach. By establishing an accepting atmosphere and giving assignments which were relevant to student concerns and experience, students who had entered the class with anxiety and negative feelings frequently changed within the first two weeks of class. About halfway through the semester, students began expressing a growing confidence in their computing abilities. These statements of confidence often accompanied those in which students reported having successfully completed assignments and/or helping other students debug programs and complete assignments.

Throughout the semester, as classroom applications were discussed, students wrote comments regarding using the computer in their classrooms. Students who were practicing teachers and had access to computers often made oral requests for more technical information needed to implement computer instruction and proudly reported the results of their computer-based lessons with their children. Statements and journal entries such as "... my attitude toward using a computer in my classroom has changed. I can see how they can and should be used to enhance lessons and concepts taught prior to computer use" are indications of commitment toward using computers in their K-12 instruction.

Implications

If the tremendous potential computers can bring to educational practices is ever to be realized, the people who design and deliver curriculum (i.e., the classroom teachers) must become proficient users of the medium and must understand how to effectively apply it within their instructional program. Positive attitudes are prerequisite to teachers adopting technology in their classroom. Thus, it is critical that these teachers be prepared in a manner that makes them comfortable with the technology and enthusiastic users in their classrooms.

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Developing the computer-competent preservice teacher

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Introduction

Teachers must be adequately prepared to use the computer as teaching and learning tools. In order for preservice teachers to be able to use computers with their students, our curriculum must provide learning opportunities for that skill development. Recognizing the need to have all teacher candidates be computer competent before entering the teacher education program and the preservice teaching experience, guidelines outlining entry level computer competency skills required for all preservice teacher were written. The guidelines were presented to the University of Nebraska-Lincoln Teachers College Faculty and were approved. This paper describes a baseline assessment of the computer skills of first year students and third year students and an assessment plan. This assessment impacts preservice teachers by teaching them the skills necessary to integrate technology into the curriculum.

Measure of Computer Competence

The TC entry level computer competencies approved by the Teachers College Faculty (May, 1992), include five skills: word processing, use of a data base/spread sheet, use of graphics, use of electronic host (e.g., networks, e-mail), and the ability to assemble and to care for a personal computer. To determine the current computer competencies of preservice teachers, a five-question survey was developed based on the the entry level computer competencies.

Students

The 1992 first year class is the first group of preservice teachers required to meet the minimal computer competencies before entering the teacher education program in their third year. Since all first year students are required to take the Foundations of Modern Education, each section of this class was selected to participate in the survey. The Audiovisual Materials Class, a third year level course, was selected because this class currently teaches computer skills needed to design and to develop educational materials. A total of 255 first year students from the ten (10) CI 131 classes and 92 third year students from the CI 359 class completed the survey during the first or second class session of the 1992 Fall Semester.

Survey Results

The results of the survey are revealed by first presenting the first year students' data which is followed by the third year students' data.

The majority of the first year students (84.3%) and third year students (66.3%) have had one or more classes dealing with computer skills. A few students (4.3%; 2.1%) stated that they learned computer skills in high

Table 1
Fall 1992 UN-L Computer Survey of Freshmen (CI 131) and Junior (CI359) Students

		CI 131		CI 359	
		N = 255	%	N = 92	%
1.	How many computer class(es) did you have in high school?				
(a)	none	40	15.7	31	33.7
(b)	one	120	47.1	46	50.0
(c)	two	49	19.2	10	10.9
(d)	three	24	9.4	3	3.3
(e)	four or more	11	4.3	0	0
(f)	integrated in courses	11	4.3	2	2.1
1.	If you did not have a computer class in high school, how did you learn to use a computer?				
(a)	no experience	9	20.9	2	6.0
(b)	on own	18	41.8	25	75.8
(c)	classes outside of school	2	4.7	3	9.1
(d)	parents/brother/sister	3	6.9	0	0
(e)	job training	7	16.3	3	9.1
(f)	college course	2	4.7	0	0
(g)	friend	2	4.7	0	0
2.	What type of computer did you use?				
(a)	Apple/Mac	105	41.2	35	38.1
(b)	IBM/compatible	63	24.7	14	15.2
(c)	both	70	27.5	37	40.2
(d)	Commodore	5	1.9	0	0
(e)	Tandy	1	.4	1	1.1
(f)	none	7	2.7	1	1.1
(g)	unknown	4	1.6	4	4.3
3.	I have the following computer skills to:				
3.1	Use a word processing program to create documents.				
(a)	yes	221	86.7	83	90.2
(b)	no	34	13.3	9	9.8
3.2	Use a database and a spread sheet program to produce data and graphics.				
(a)	yes	125	49.0	27	29.3
(b)	no	130	51.0	65	70.7
3.3	Use an electronic host system (e.g., network, e mail).				
(a)	yes	37	14.5	5	5.4
(b)	no	218	85.5	87	94.6
3.4	Assemble a computer (put together your personal computer).				
(a)	yes	46	18.0	8	8.7
(b)	no	209	82.0	84	91.3
3.5	Maintain/care for a computer system.				
(a)	yes	93	36.5	17	18.5
(b)	no	162	63.5	75	81.5

continued on next page

Table 1 (continued from previous page)

		CI 131		CI 359	
		N = 255	%	N = 92	%
4.	If you were to be tested for your competence in the above skills, how would you do this?				
(a)	standardized test	59	23.1	3	3.3
(b)	projects	173	67.8	76	82.6
(c)	both	6	2.4	8	8.7
(d)	no response	17	6.7	5	5.4
5.	Do you own a computer?				
(a)	no	166	65.1	68	73.9
(b)	yes	81	31.8	24	26.1
(c)	no response	8	3.1	0	0
(d)	Type: Apple/Mac	27	33.3	10	41.6
(e)	IBM/compatible	37	45.7	12	50.0
(f)	Commodore	4	4.9	1	4.2
(g)	Tandy	3	3.7	0	0
(h)	word processor	2	2.5	1	4.2
(i)	both Apple/IBM	3	3.7	0	0
(j)	home made	1	1.3	0	0
(k)	no response	4	4.9	0	0

school courses such as English, journalism, math and chemistry. If students did not have such opportunities in high school, they learned computer skills on their own (41.8%; 75.8%), or as part of job training (16.3%; 9.1%).

It was surprising to find that many of the students (27.5%; 40.2%) used both Apple and IBM during their training. However, most students were trained on Apple or Macintosh computers (41.2%; 38.1%) followed by IBM or IBM Compatible computers (24.7%; 15.2%). A majority of the students (65.1%; 73.9%) did not own a computer. Even though more students were trained on Apple/Macintosh computers, they purchased IBM (45.7%, 50%) more than Apple (33.3%; 41.6%).

The majority of students (86.7%; 90.2%) used the computer for word processing. Some students have used a data base/spread sheet (49%; 29.3%) but only 14.5% of the first year students and 5.5% of the third year students have used some type of electronic host. Few students (18%; 8%) know how to assemble a personal computer, but more first year students (36.5%) than third year students (18.5%) know how to care for a computer.

The students were asked how they would prefer to have their competencies assessed. The majority of the students (67.8%; 82.6%) wanted a hands-on project to demonstrate their computer competencies.

The results of this survey supplied baseline information on the computer skills of the 1992 Teachers College Freshmen class and the 1992 Junior preservice teachers. It has also aided in developing the assessment plan by indicating where the students needed additional skill development.

Assessment Plan

Since the majority of the students preferred a hands-on project to demonstrate their computer competencies and skills, the following two-part assessment plan was developed. The first part is a self-paced instruction project in which the student learns the necessary software programs for the establishment of an educational portfolio. The portfolio will include: (a) a personal photograph and a data sheet; (b) a resume; (c) a graph and a paragraph explaining how students spend their daily time (this is converted into a visual transparency for presentation); (d) an informational poster that is dry-mounted for presentation; (e) a ten-question multiple-choice quiz using a single page and a double page format; and (f) communications with others using an electronic host such as TC forum. These activities were selected because they are based on the guidelines, they integrate computer skills, and they are curricular and professional materials used by a teacher.

After the students complete their educational portfolio, an appointment is made to do part two, the final assessment project. This assessment is completed under supervision of the assessment director. The final project is a combination of the portfolio activities designed into a newsletter and is graded Pass or No pass. If students do not pass, they will repeat the final project until it is acceptable.

Facilities and Instructional Material

The Teachers College Teaching Technology Enhancement Center was established specifically to help students who need individual assistance. Students enrolled in the Audiovisual Classes and those completing the first part of the assessment (portfolio development) are encouraged to drop-in to receive help. Two student assistants with computer knowledge are available to assist these students. Help sheets on the use of software packages (Microsoft Word, SuperPaint, PageMaker and Excel) as well as the instructional material for developing a portfolio were designed and distributed to the first year students on computer disks. All of this information is also available on the computers in the TC Assessment Room and on the server in the TC Instructional Design Center.

Conclusion

This program is in its the first year of implementation. All students entering teacher education must meet the prescribed entry level computer skills. Since the aim of this requirement is to develop computer-competent preservice teachers, mastery of various skills and software packages are necessary to produce a portfolio of curricular and professional materials. The baseline data will aid in determining the effectiveness and progress of the TC entry level technology skills program. The ultimate measure of the impact of this assessment will be if these students have the skills necessary to integrate technology into their teaching.

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RESEARCH Section 2

Introduction

The research portion of this year's annual is divided into four sections. The studies in Section one, *Teacher and Student Attitudes Toward Technology*, focus on various aspects of teachers' and students' attitudes toward technology. Section two, *Research on Access and Use of Technology*, includes four studies that examine the access and use of technology in school districts. Section three, *Evaluative Studies*, includes several studies that evaluate state-wide initiatives on technology as well as local projects on technology. In the final section, *Chaos and Order*, we find two articles that present contrasting points of view of research in the field of technology and teacher education.

Teacher and Student Attitudes Toward Technology

In the study, *Effects of Computer Experience on Computer Attitudes among Preservice, Inservice, and Postulant Teachers*, Cliff Liao found that the longer the exposure of computers and the more types of computers which education majors had experienced, the more positive attitudes they had developed. He also found that there were several significant differences among the preservice, inservice, and postulant teachers. In their article, *Preservice Teachers' Computer Attitudes in Non-Computer Classes*, John McEneaney and his colleagues found that three factors account for preservice teachers' attitudes toward computers: (a) positive feelings for computers, (b) utility of computers, and (c) negative feelings for computers.

In her article, *Education Students' Attitudes Toward the Effectiveness of Instructional Technology*, Yolanda Padron investigated education students' attitudes towards the effectiveness of various types of instructional technology. She found that education students generally had positive attitudes toward various types of technology, but they also thought that the use of technology generally was more appropriate at the high school level than the elementary school level.

Susan Huang's study, *Investigating Middle School Students' Attitudes Toward Calculator Use*, alerts us of the finding that although students see the positive benefits of using calculators, they are also concerned about its uses. Many students do not think that they should be allowed to use calculators udring tests and many think that calculators will decrease their computational ability and estimation skills. Suprisingly, Huang did not find any sex-related or ehtnic-related differences among students on their attitudes toward calculators.

Research on Access and Use of Technology

In this section, there are four studies that focus on the accessibility and use of technology in schools. In his

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study, *Technology Access and Use in Urban, Suburban, and Rural Eighth Grade Mathematics Classrooms,* Emiel Owens examines the access and use of technology in urban, suburban, and rural eighth grade mathematics classrooms. The results of his study indicate that rural teachers reported that they were less likely to use technology than teachers from suburban and urban schools. Urban teachers also reported that their students were more likely to use computers for *remediation* than suburban and rural teachers. In the next article of this section, *Investigating Computer Use in Elementary and Middle School Inner-City Classrooms,* Hersh Waxman and Susan Huang examine the extent to which computer technology was integrated into the curriculum of 200 elementary and secondary school inner-city classrooms. Systematic classroom observations revealed that there was virtually no integration of computer technology in these classes.

In the next study in this section, *Classroom Observations of Middle School Students' Technology Use in Mathematics,* Susan Huang and Hersh Waxman conducted systematic classroom observations in middle school mathematics classrooms to examine whether or not there were gender, ethnic, or grade-level differences in students' use of technology. The multivariate of analysis results revealed that there were only grade-level differences among students on their use of technology. In the last study of this section, *Instruction with Technology: Differences Between Experienced and Novice Teachers,* Janice Mitchell and her colleagues investigated differences between experienced and novice teachers' classroom instruction and use of technology in middle school mathematics. The results indicated that there were significant differences between experienced and novice teachers on their classroom instruction, but they did not observe any significant differences between the groups on teachers' instruction with technology nor on student activities with technology.

Evaluative Studies

In this section, there are two state-wide evaluation studies and the other articles either focus on specific projects or ways to collect evaluative data. The Roblyer and Barron study, *Technology in Teacher Education: A Florida Study,* was conducted to investigate issues related to the integration of technology in teacher education programs in Florida. Several faculty members at each of the nine state universities were interviewed through a questionnaire that focused on three aspects of technology integration: (a) the degree to which technology-based skills are being addressed in major content areas; (b) the amount of perceived access that students and faculty have to technology resources; and (c) the obstacles that faculty perceive are impacting their use of technology in teacher education courses. Trish Stoddart and her colleagues' study, *School Restructuring Through an Educational Technology Initiative: One State's Experience,* examined the state of Utah's plan for implementing technology in school districts and colleges of education. They found that computer vendors were influential in software and hardware installation and in teacher training. The results also indicated that computer-assisted instruction improved the mathematics and reading scores of low-achieving students.

In her study, *Technology Development for Educators: Three Models of Implementation,* Lynne Schrum describes an investigation of three school districts as they developed models for technology implementation, to gather reflections from those involved and to inform future energies to this end. The White, Troutman, and Chancey study, *Accessing ICLAS Network Log Data to Quantify Student Computer Usage in Relation to Course Performance and Attitude Change,* found that there were no changes in preservice teachers' attitudes about the use of computers in schools.

Mary Planow and her colleagues' study, *Structuring Teachers' Attitudinal Changes: A Follow-up Study,* examines a project designed to prepare teachers to integrate computers into the curriculum through intensive inservice, access to resources, and follow-up support. Pre- and post-tests were designed to capture teachers' perceptions of computers and of their comfort and skill levels with respect to using computers for instruction. Changes in attitudes after one year were measured by t-test analyses using paired samples. In the final article in this section, Susan Anderson's article, *Research on Educational Telecomputing: Collecting Data Via Computer,* discusses the availability and use of telecomputing networks in education and raises issues about how to implement and effectively apply them. This study used a telecomputing system for data collection and found that the methodology employed appeared to be effective.

Chaos and Order

In this final section, two extreme points of view of educational research are presented: (a) chaos, and (b) research paradigms and methods in technology and teacher education. In their paper, *Chaos and Education,* Ralph Cafolla and Dan Kauffman discuss the science of chaos and its significance to education. The authors also provide a provocative discussion on how education systems are dynamic systems that require nonlinear solutions rather than traditional linear methods. They believe that chaos is an electrifying frontier for education and holds much promise for a deeper understanding of human learning, and hence to teacher education. The other article in this section, *Conducting Technology and Teacher Education Research: The STATE Monograph,* by Hersh Waxman and George Bright introduces the research monograph, *Approaches to Research on Teacher Education and Technology* (Waxman & Bright, 1983), and briefly describes the articles that comprise it. In addition, they suggest ways for improving the research on technology and teacher education are made.

Future Directions

In the their last chapter on the future of research technology and teacher education, Bright and Waxman (1993) discuss several areas in the study of technology and teacher education that hold promise for improving educators. The articles in the present annual, however, also suggest several areas that need additional inquiry. Research related to teacher and student attitudes toward technology, for example, needs to be continued. This paradigm should also be expanded to include other outcome measures such as behavior in classrooms or academic achievement. Studies on the access and use of technology in schools need to begin to focus on other outcome measures, too. In particular, we need to know under *what conditions* should technology be integrated into the curriculum and *why*. Evaluative research studies similarly serve a very important role in the field of technology and teacher education. Evaluation results often impact educational policy and practice and more evaluative studies of technology projects need to be conducted and disseminated to the public.

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Effects of computer experience on computer attitudes among preservice, inservice, and postulant teachers

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The microcomputer as a new technology has been widely used in the nation's schools. The number of computers in use in schools has increased at an unprecedented rate. Wright (1984), for example, reported that in 1982, 38% of schools had computers, but in 1988, 91% of schools had computers (Ordovensky, 1989). By the end of the 1980s, the number of microcomputers in use in schools was estimated to be 2.4 million (Becker, 1990).

While microcomputers have been increasingly used in schools, students' and teachers' attitudes toward them were also noticed. When computers are introduced into the classroom, students' attitude toward this new technology may influence their ability to use them successfully. Studies have identified significant relationships between computer attitudes and computer literacy among college students (Dambrot, Watkins-Malek, Silling, Marshall, & Garver, 1985; Mercoulides; 1988; Wiggins, 1984). Clement (1981) reported that, in general, students' attitudes toward computer-based courses have been found to be positive among students in junior high schools, high schools, community colleges, and colleges. These positive attitudes toward computers make the interaction with computers a pleasant and rewarding experience. Positive attitudes increase the prospect for achievement in any academic endeavor, whereas negative attitudes make achievement of competence less likely (Loyd and Gressard, 1984). Many studies examined students' attitudes toward computers at varied school levels (e.g., Campbell, 1989a; 1989b; Chen, 1986; Collis & Williams, 1987; Loyd & Gressard, 1984; 1986; 1988) and reported that factors such as gender and prior computer experience may have some influence on students' liking of, anxiety about, and confidence in using computers.

Significant correlations between computer attitudes and computer literacy have been found among educators by Brooks (1987), Coffey (1984), Mitchell (1985), and Newman (1982). Teachers' attitudes toward computers can also influence students' computer attitudes. A number of studies have investigated teachers' attitude about school use of computers and anxiety about computers (Kay, 1989; Koohand, 1987; Marshall & Bannon, 1986). However, very little research has specifically looked at the possible differences on computer attitudes among preservice, inservice teachers, and postulants (i.e., post bachelor students working for teaching certification).

The major purpose of the present study was to examine the effects of prior computer experience on computer attitude among preservice, inservice teachers, and postulants. More specifically, this study attempted to examine the effects of previous (a) length of computer experience (i.e., less than 1 year, 1-2 years, and more than 2 years), and (b) type of computer used (i.e., Macintosh, IBM, Apple II, two types of computers, and more than two types of computers) on computer attitudes among preservice, inservice teachers, and postulants.

Method

Subject

The subjects in the present study were 207 education-majored students from a state-supported, public university located in a major metropolitan city in the Southwest. Nearly 85% of the subjects were female and about 76% of them were white. In addition, 75% of the subjects were between the age of 18 and 35. The university participated in the present study had a teacher education program in which an introductory computer literacy course was required for all preservice, inservice teachers, and postulants. In the present study, 117 were preservice teachers, 56 were inservice teachers, and 34 were postulants.

Computer literacy course

The content of the computer literacy course taught by the university involved in the present study included: (a) word processing, (b) database, (c) spreadsheet, (d) Logo, and (e) BASIC. This model of computer literacy was consistent with that proposed by Thompson and Friske (1988) in which several applications were emphasized and programming was only a component part. Owing to the limit number of computers, the course was taught in two different computer labs; about 72% of the subjects participated in the present study were taught in a networked Macintosh computer lab while the remaining subjects were taught in a non-networked IBM-compatible lab. The general expectation for that course is for education-majored students to achieve a simple level of operation of applications software (e.g., word processing) and to write simple programs in Logo and BASIC. In addition, these students were also expected to develop an understanding of computing, social issues regarding computer use, and the historical development of computer technology. Although it is not an emphasis in the computer literacy course, the development of a positive attitude toward computing and conceptual base of problem-solving skills from the course were also expected.

Instrument

The instrument used in the present study was a Computer Attitude Scale developed by Loyd & Gressard (1985) that was designed to measure student's attitude toward computing. The Scale consists of 30 Likert-scale type of questions for three subscales: computer anxiety, computer confidence, and computer liking. Each subscale consists of ten items and presents positively and negatively worded statements. Students responded to the statements by selecting one of four responses: "strongly agree", "somewhat agree", "somewhat disagree", and "strongly disagree." Scores on each subscale are interpreted as 'the higher the score the more positive the attitude (e.g., lower anxiety or higher confidence)'. Three scores from each subscale would then add together to produce a computer-attitude score. The Scale has been found to be reliable and valid, and has been previously used with students at varied school levels (Loyd & Gressard, 1984; Loyd & Gressard, 1986; Loyd & Loyd, 1988; Massoud, 1990; Massoud, 1991).

Procedures

Near the end of the Fall academic semester, 1990, all participants completed the Computer Attitude Scale. The data was collected and coded. A 3 x 3 x 5 Factorial analysis of variance (ANOVA) was performed to investigate if there were any statistically significant (*p* <. 05) differences on computer attitudes among: (a) students with different classifications (i.e., preservice teachers, inservice teachers, and postulants), (b) students who had different levels of prior computer experiences (i.e., less than 1 year, 1-2 years, and more than 2 years), (c) students who had different types of prior computer experiences (Macintosh, IBM, Apple II, two types of computers, and more than two types of computers), and (d) interactions among these three factors (i.e., classifications, length of computer experiences, and type of computer used).

Results

Means and standard deviations for each variable are presented in Table 1. The results show that the overall means were 28.6 (71%), 28.17 (70%), and 28.3 (70%), out of a maximum score of 40, for classification, length of experience, and type of computer used, respectively. The highest mean for classification was inservice teachers' score on liking, and the lowest was postulants score on anxiety. In addition, inservice teachers outscored preservice teachers and postulants on all three subscales. The highest mean for length of experience was found on confidence for students who had more than 2 years of computer experience; and the lowest was on anxiety for those who had less than 1 year of experience. Finally, the highest mean for type of computer used was on confidence with students who have used more than two types of computers while the lowest mean was on anxiety with students who only used Mac computers.

Table 2 summarizes the 3 x 3 x 5 Factorial ANOVA. The results of the ANOVA indicated that there was a significant main effect for classification on liking (F = 3.06, df = 2/162, p < .05). Additionally, the length of experience was found to have a significant main effects on two subscales: anxiety (F = 4.22, df = 2/162, p < .05) and confidence (F = 4.50, df = 2/162, p < .05), and total

Table 1
Summary of Means and Standard Deviations on Variables

Scale	Anxiety[1]		Confidence		Liking		Total Score[2]	
Variable	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
Classification								
Preservice ($N = 117$)[3]	27.35	6.03	28.93	4.52	27.74	5.57	84.03	14.18
Inservice ($N = 56$)	28.46	5.77	30.52	5.53	30.96	5.95	89.95	15.39
Postulant ($N = 34$)	26.62	5.30	28.21	4.75	28.62	5.43	83.44	13.62
Length of Experience								
Less Than 1 Year ($N = 72$)	24.16	5.46	26.86	4.11	26.53	5.75	77.56	13.31
1-2 Years ($N = 30$)	27.30	5.29	28.70	4.12	28.63	5.06	84.63	12.17
More Than 2 Years ($N = 104$)	29.96	5.08	31.07	4.88	30.36	5.54	91.39	13.47
Type of Computer Used								
Mac ($N = 40$)	25.75	5.98	27.75	4.47	29.25	5.68	82.75	14.21
IBM ($N = 35$)	26.06	5.51	27.14	4.62	26.23	4.56	79.43	12.41
Apple II ($N = 30$)	26.20	5.07	28.60	4.71	27.20	6.40	82.00	14.13
Two Types ($N = 60$)	28.57	6.33	30.13	5.08	29.02	5.88	87.72	15.85
More than Two Types ($N = 42$)	29.93	4.83	31.60	4.20	31.14	5.33	92.67	11.93

Note.1. The possible maximum score for each scale is 40.
2. The possible maximum score for total score is 120.
3. The number of subjects is presented in parenthesis.

Table 2
Summary of Three-Factor-ANOVA

		Anxiety		Confidence		Liking		Total Score	
Source of Variation	*df*	*MS*	*F*	*MS*	*F*	*MS*	*F*	*MS*	*F*
Classification (A)	2	1.32	.05	12.68	.70	84.92	3.06*	63.29	.39
Length of Experience (B)	2	117.90	4.22*	81.16	4.50*	58.67	2.11	716.97	4.38*
Type of Computer (C)	4	58.03	2.08	49.52	2.75*	100.84	3.63**	485.91	2.97*
A X B	4	18.93	.68	6.72	.37	26.11	.945	9.60	.36
A X C	8	24.97	.89	39.34	2.18*	23.32	.842	20.03	1.35
B X C	8	25.87	.93	19.93	1.11	45.33	1.632	27.55	1.39
A X B X C	16	19.59	.70	11.42	.63	9.71	.35	68.14	.42
Error	162	27.94		18.02		27.76		163.55	

* $p < .05$ ** $p < .01$

Table 3
Summary of Descriptive Data for Classification by Type of Computer Used on Confidence

	Preservice	Inservice	Postulants
Mac			
N (Percentage)	28 (13.5%)	10 (4.8%)	2 (1%)
Mean	28.39	27.00	22.50
SD	4.31	4.62	3.54
IBM			
N (Percentage)	15 (7.2%)	10 (4.8%)	10 (4.8%)
Mean	28.00	25.30	27.70
SD	4.02	5.56	4.37
Apple II			
N (Percentage)	13 (6.2%)	6 (2.9%)	11 (5.3%)
Mean	28.31	33.67	26.18
SD	4.35	4.37	3.19
Two Types	37 (33.8%)	20 (9.7%)	3 (1.4%)
Mean	28.46	32.55	34.67
SD	4.92	4.37	2.08
More Than Two Types			
N (Percentage)	24 (11.6%)	10 (4.8%)	8 (3.9%)
Mean	31.21	33.30	30.63
SD	4.09	3.89	4.84

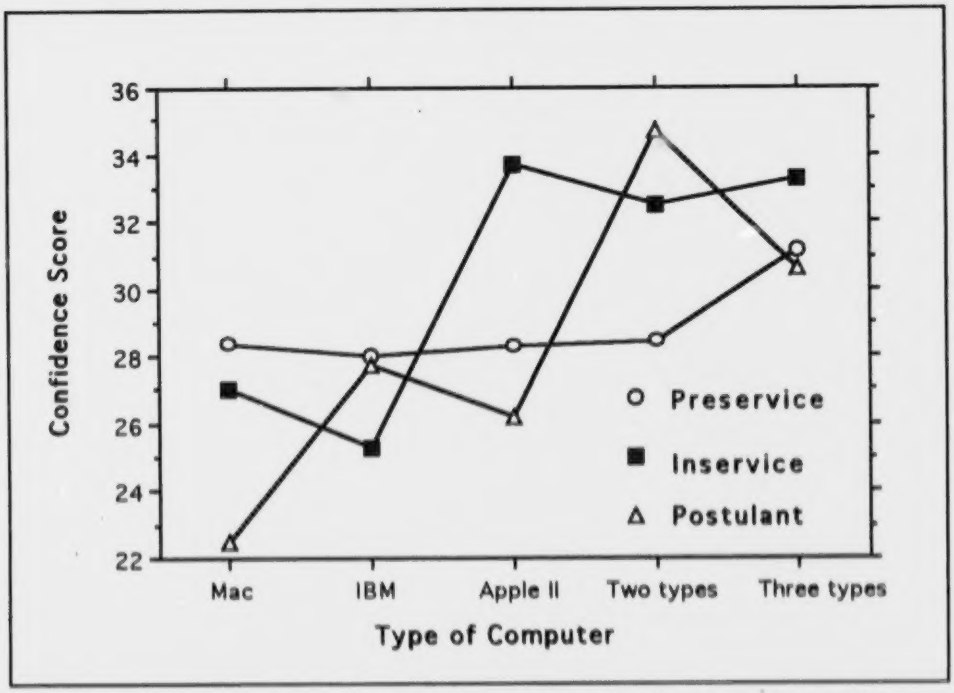

Figure 1. Classification x Type of Computer Interaction Using Confidence Score

Table 4
Summary of Fisher's Protected LSD Test on Each Significant Main Effect

Subscale Variable	Anxiety	Confidence	Liking	Total Score
Classification				
inservice			> preservice	
			> postulants	
Length of Experience				
more than 2 years	> less than 1 year	> less than1 year	> less than 1 year	> less than 1 year
	> 1-2 years	> 1-2 years		> 1-2 years
1-2 years	> less than 1 year	> less than 1 year		> less than 1 year
Type of Computer Used				
more than 2 types	> Mac	> Mac		> Mac
	> IBM	> IBM	> IBM	> IBM
	> Apple II	> Apple II	> Apple II	> Apple II
			> 2 types	
2 types	> Mac	> Mac		
	> IBM	> IBM	> IBM	> IBM
	> Apple II			> Apple II
Mac			> IBM	

attitude as well (F = 4.38, df = 2/162, p < .05). Significant main effects were also obtained for type of computer used on two subscales: confidence (F = 2.75, df = 4/162, p < .05) and liking (F = 3.63, df = 4/162, p < .01), and total attitude (F = 2.97, df = 4/162, p < .05). Moreover, the interaction of classification and type of computer used for confidence was also significant (F = 2.18, df = 8/162, p < .05). Table 3 shows the descriptive data for the interaction. An interaction graph is also displayed in Figure 1. No other significant main effects or interactions were found.

For those variables that showed a significant main effect on students' attitudes toward computers a follow-up analysis (Fisher's Protected LSD) was employed. Table 4 displays a summary of the results of the Fisher's Protected LSD tests for those significant main effects. The results of the follow-up analysis for classification show that inservice teachers scored significantly higher than preservice teachers and postulants on liking.

The results of the follow-up analysis for the length of computer experience indicate that students with more than 2 years of computer experience scored significantly higher than students who had less than 1 year of computer experience on all 3 subscales of computer attitude and total. In addition, students who had more than 2 years of computer experience scored significantly higher than students with 1-2 years of computer experience on anxiety, confidence, and total. Also students with 1-2 years of computer experience significantly outscored students who had less than 1 year of experience on computer anxiety, confidence, and total.

The results of the follow-up analysis for the type of computer used indicate that students with more than two types of computer experiences scored significantly higher than students who have experienced only one type (Mac, IBM, or Apple II) of computer on anxiety, confidence, and total. Students who have experienced more than two types of computers were significantly higher than students who have experienced two types of computers or used only IBM or Apple II computers on liking. In addition, students with two types of computer experiences scored significantly higher than students who have experienced only one type (Mac, IBM, or Apple II) of computer on anxiety. Students who have experienced two types of computers were significantly higher than students who have used only IBM or Mac computers on confidence. Also, students with two types of computer experiences scored significantly higher than students who have used only IBM or Apple II computers on total. Students with two types of computer experiences scored significantly higher than those with only IBM experience on liking. Finally, students had only Mac experiences were significantly higher than those who had only IBM experience on liking.

Discussion

Significant findings regarding the overall means for classification, length of computer experience, and type of computer used were all about 28 or 70%, out of a maximum score of 40, suggest that most subjects participated in the present study had a positive attitude toward computers. Although the results were possibly attributed to many other factors, based on the outcomes of this study, prior computer experiences were found to be a critical factor, among others, for this positive tendency. However, without further research, it is difficult to identify to what extend prior computer experience influence these positive attitudes.

The findings that students who have 1-2 years or more than two years of computer experiences scored significantly higher than students who have computer experience less than 1 year suggest that students may develop their positive attitude if they were allowed to experience on computers for more than one year. Since studies have found that there was significant relationship between computer attitudes and computer knowledge (Dambrot, Watkins-Malek, Silling, Marshall, & Garver, 1985; Mercoulides; 1988; Wiggins, 1984), it is reasonable to believe that longer exposure to computers may reinforce students' computer knowledge and therefore increase their positive attitudes. However, the findings of no significant differences for computer experiences between 1-2 years and more than 2 years seem to suggest that the critical period of experience for students' to increase their positive attitudes toward computers is one year.

The findings of significant differences among students who have experienced more than two types of computers, two types of computers, and only one type of computer on each subscale suggest that students will increase their positive attitude if they have experienced more types of computers. A possible explanation is that when students experience more types of computers, they may also gain more knowledge about computers and therefore enhance their positive attitudes toward computers.

The finding of students with Mac experiences scored significantly higher than students with IBM experiences on liking indicate that education-major students seem to like Mac more than IBM. However, without a significant interaction between type of computer used and length of computer experience, it is difficult to predict if this Mac-favor attitude will change after a period of time. The finding of significantly higher scores for inservice teachers over preservice teachers on the computer liking indicates that inservice teachers are possibly more likely to use computers than preservice teachers. This is possibly because inservice teachers have more opportunities to either be exposed to various types of computers or spend longer time on computers in their schools.

Conclusion

Earlier research on computer attitudes has reported that prior computer experience may have some influence on students' liking of, anxiety about, and confidence in using computers (e.g., Campbell, 1989a, 1989b; Chen, 1986; Collis & Williams, 1987; Loyd & Gressard, 1984, 1986, 1988). The outcomes of the present study agree with their findings. The results of this study indicate that, in general, the longer exposure of computers and the more types of computers which education-majored students have experienced, the more positive attitudes they may establish. These suggest that teacher educators in computing may encourage students to experience various types of computers or spend longer time on computers to develop students' positive attitudes toward computers.

Since microcomputers have been widely used in the nation's schools, teachers in the 1990s will find it more difficult to avoid using computer in schools. Development of positive attitude toward computers may help teachers to gain necessary knowledge and skills to be competent teachers for the 1990s. Based on this fundamental understanding, how to develop positive computer attitudes for students in the teacher education program becomes a critical topic for teacher educators in computing. The findings of the present study have provided some useful information on the issue.

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Preservice teachers' computer attitudes in non-computer classes

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Computers are playing important roles in education and training at many levels. This is especially true of higher education where students frequently are required to take computer-oriented courses or demonstrate proficiency in basic computer literacy in order to achieve degree objectives. Students do not always approach computer use with enthusiasm however and numerous recent studies have explored student attitudes toward computers and how they relate to learning. Most studies investigating preservice teachers' attitudes toward computers have, however, drawn subjects from required computer classes or from elective courses into which students self-select. The purpose of the present study is to investigate the computer attitudes of preservice teacher education students in reading, mathematics, and science education methods courses which have not traditionally placed emphasis on the role of computers in the classroom. The present investigation will focus on two major research questions:

1) What factors appear to be required in order to account for the computer attitudes of preservice teacher education students?
2) Are there differences in the computer attitudes of different populations of preservice teacher education students?

Our first question concerns the theoretical structure of preservice teachers' computer attitudes. Although the number of postulated dimensions for computer attitudes has usually involved 1 to 3 factors, most studies exploring the dimensionality of computer attitudes have focussed on specific instruments. In one recent exception to this trend Woodrow (1991) administered four different attitude scales to preservice teachers and factor analyzed responses across all four scales. Her results suggest as few as three theoretical factors that she labelled "Computer liking", "Computer anxiety", and "Social and educational impact of computers" may be adequate to account for preservice teachers' computer attitudes. An important limitation of the Woodrow study, however, was its use of a relatively small sample of subjects (n=98) drawn from an elective computer education course, a limitation which leaves some important questions unanswered.

It may be, for example, that students selected from a computer education elective course view computers differently than students in other kinds of courses (e.g., non-computer courses). Given the tendency for computer education courses to be add-ons to the core methods curriculum it could reasonably be argued, if differences in factor structure or attitude measures are found, that the truer picture of preservice teachers' attitudes and their underlying factor structure should emerge from their *methods courses*, which generally play a much larger role in their professional training and which probably more closely correspond to the situational context in which those students will ultimately work (i.e., Most teachers will not teach in a computer lab.) Woodrow (1991), indeed, recognizes the limitations of her study and recommends that a useful follow-up would be to administer the same set of attitude scales to a wider population of subjects that includes students not enrolled in computer elective courses. The purpose of the present study is to provide such a follow-up study.

Subjects and Method

Development of the attitude measure was similar to the procedures used in the Woodrow (1991) study. Items from four instruments including the Computer Use Questionnaire (Griswold, 1983), the Computer Attitude Scale (Loyd & Loyd, 1985; Gressard & Loyd, 1986), eleven attitude and anxiety items from the Computer Survey (Stevens, 1980, 1982), and the Attitudes Toward Computers scale (Reece & Gable, 1982) were assembled in random order into a single measure consisting of 71 computer attitude items and 14 items requesting demographic and previous computer experience information. Due to an error in printing one item (#8) from the Confidence subscale of the Computer Attitude Survey was omitted from approximately a third of the instruments used in the study.

The composite attitude instrument was administered to approximately 200 preservice teacher education students from two public universities in Texas and Indiana early in the Fall of 1992. Students participating in the survey were enrolled in non-computer education methods courses that have not traditionally emphasized the role of technology in education.

Data Analysis

All data analysis was carried out in SAS (Version 6) under the VAX/VMS operating system. Data were analyzed in two stages. The first stage of data analysis involved a series of factor analyses to determine the underlying factor structure of the subjects' attitudes. Although Woodrow's analysis provided a useful reference point, the intent was not to simply replicate Woodrow's analysis since there could be no guarantee that the underlying factor structures of the two populations were identical. Data analysis in this stage began with a principal components analysis followed by both orthogonal and oblique rotations that specified numbers of factors for extraction as suggested by results of the prior analyses. Following the factor analysis of the items in the composite scale, scores for each student on each of the four instruments were also factor analyzed.

In the second stage of data analysis means and standard deviations for each of the computer attitude scales used in the study were computed so that comparisons could be made to scores reported by Woodrow (1991). One goal of this analysis was to test a prediction by Woodrow (1991) that the attitudes of subjects not enrolled in elective computer courses would be more negative than those in her study (who were enrolled in an elective computer course).

Results and Discussion

Since one of the Computer Confidence items (#8) was omitted on a third of the surveys used, data analysis was limited to 70 items. Although the omission of this item represents a limitation, it seems unlikely to have significant effects on the analysis as a whole given the total number of items involved. A principal components analysis of those 70 items resulted in 15 components accounting for approximately 71% of the survey variance with the first seven factors accounting for approximately 56%. These results were similar to those obtained in the Woodrow study with few or no item loadings that exceeded .40 on factors 8-15.

Table 1.
Inter-factor correlations for the 7-factor oblique solution across all items.

	Fact1	Fact2	Fact3	Fact4	Fact5	Fact6	Fact7
Fact1	100*	45*	-51*	17	1	24	-23
Fact2	45*	100*	-48*	35	10	21	-8
Fact3	-51*	-48*	100*	-10	-4	-22	17
Fact4	17	35	-10	100*	2	4	16
Fact5	1	10	-4	2	100*	-1	7
Fact6	24	21	-22	4	-1	100*	-31
Fact7	-23	-8	17	16	7	-31	100*

NOTE: Printed values are multiplied by 100 and rounded to the nearest integer. Values greater than 0.36 and less than -0.36 have been flagged by an '*'.

Table 2.
Factor loadings for each scale and sub-scale score on the single factor that emerged from the principal components analysis of the scale and sub-scale scores.

SCALE or SUBSCALE	FACTOR LOADING
Computer Attitude Scale (Total scale)	97
Computer Anxiety Subscale	89
Computer Confidence Subscale	92
Computer Liking Subscale	90
Attitudes Toward Computers Scale	87
Computer Use Questionnaire	78

NOTE: Factor loadings have been multiplied by 100 and rounded to the nearest integer.

Following the principal components analysis an orthogonal (Varimax) rotation that specified 7 factors was applied. This analysis accounted for approximately 39% of the total variance. Of this variance Factors 1, 2, and 3 accounted for 10.7%, 10.3%, and 7.6%, respectively, for a total of about 29%. Factors 4-7 each contributed less than 4% for a total of about 10%.

Following the orthogonal rotation specifying 7 factors, an oblique (Promax) rotation specifying 7 factors was carried out. Results of this analysis also suggested an underlying structure composed of three factors. Table 1 provides inter-correlations for the 7 factors resulting from the oblique rotation. As indicated in the table, Factors 1, 2, and 3 correlated fairly highly with one another although Factor 3 was found to correlate negatively with 1 and 2. None of the remaining factors correlated with each other or with Factors 1, 2, or 3 above .36 or below -.36.

At this point data analysis turned to the scores obtained by students on each of the instruments included in the composite measure. Although three factors seemed to be emerging from the analysis of the items, it was not clear whether those factors would be most appropriately treated as orthogonal in nature. It was reasoned that a factor analysis of the instrument scores would help in making the decision about the kind of rotation (orthogonal or oblique) to employ in the final factor solution. Results of a principal component analysis of the instrument scores (See Table 2) revealed only a single factor with an eigenvalue exceeding 1.0 that accounted for approximately 80% of the variance with all seven scale and sub-scale scores loading at or above .78. As a result of the findings up to this point, we concluded that an orthogonal three-factor solution was unlikely and decided to apply an oblique rotation.

Results of the oblique three-factor rotation once again supported an underlying solution of three related factors. Only four of the 70 items failed to load at or above .40 (or below -.40) on one of these three factors. Factor 1 dominated the solution accounting for about 22% of the variance. Factors 2 and 3 accounted for 4.9% and 3.5% respectively. Overall, the three factors accounted for about 31% of the variance. Inspection of the item loadings suggests Factor 1 taps positive feelings for computer use since most items loading on this factor were either positively worded (e.g., "I enjoy computer work.") or were negatively loaded items suggesting the absence of positive affect (e.g., "I don't enjoy talking with others about computers.") Factor 2 appeared to be dominated by cognitively oriented attitudes concerning the **utility** of computers (e.g., "Computers can be a useful instructional aid."), with 14 of the 20 cognitively oriented Computer Use Questionnaire items loading on this factor. Finally, Factor 3 appears to represent **negative feelings** for computer use since 16 of the 17 items loading on this factor were negatively worded, many of them suggesting strongly negative feelings (e.g., "I feel aggressive and hostile toward computers.")

Stage 2 of our data analysis focussed on the scores obtained by our students on each of the instruments included in the composite. Since the intent of this analysis was to compare our results with those reported by Woodrow (1991), the data in Table 3 include Woodrow's results as well as results of population t-tests comparing the attitude means of students in our study with those reported by Woodrow (treated as the population). All student responses were recoded so that higher means corresponded with more positive attitudes. In addition, all means and standard deviations were rescaled to a single range of 10-50 so that comparisons could be more easily made. Rescaling of the means also addressed the issue of the missing item from the Computer Confidence (CC) subscale of the Computer Attitude Survey (CAS).

Table 3
Rescaled mean scores (range=10-50), standard deviations, and results of t-tests to assess significant differences between Woodrow (1991) and McEneaney et al. (1992) studies.

	Woodrow (1991)		McEneaney et al. (1992)		*t-pop* (2 tailed)		
INSTRUMENT	**Mean**	**SD**	**Mean**	**SD**	*t*	*p*	*df*
Computer Survey	36.6	4.09	36.27	3.99	-1.10807	0.2693	186
Computer Use Quest.	34.8	3.7	37.68	4.02	10.5209	0.0000	182
Attitudes Toward C.	37.9	6.4	38.23	6.08	0.69501	0.4879	184
Computer Attitude[1]	35.63	5.9	36.64	6.09	5.57644	0.0000	172
Anxiety scale	35.7	6.0	37.65	6.91	4.45374	0.0000	187
Confidence scale[2]	35.0	6.6	36.98	6.27	4.09340	0.0000	186
Liking scale	36.1	6.3	35.06	6.72	-2.22610	0.0272	181

1. Mean and SD based on 29 (rather than 30) items due to the omission of Computer Confidence item #8 from survey.
2. Mean and SD based on 9 (rather than 10) items due to omission of item #8.

Although the omission of one item represents an obvious limitation, the rescaling of means provides a meaningful basis for comparison, that limitation notwithstanding.

Surprisingly, means of students in our methods courses appear to be significantly **higher** than those reported by Woodrow for students in an elective computer course, contrary to Woodrow's prediction and our expectation. According to the population t-tests conducted using our data and the means and standard deviations provided by Woodrow (1991, p. 172), although the Canadian students had slightly more positive Computer Liking subscale scores, the methods students had significantly more positive scores on the Computer Use Questionnaire, the Computer Attitude Scale overall score and the Computer Anxiety and Computer Confidence subscales.

Summary and Conclusions

Results of the present research support the hypothesis that three related factors account for preservice teachers' attitudes toward computers. Inspection of item loadings on these three factors suggest labels of "Positive feelings for computers", "Utility of computers", and "Negative feelings for computers." These three factors appear consistent with results that have been reported recently in a similar study (Woodrow, 1991) that identified factors labelled "Computer liking", "Social and educational impact of computers", and "Computer anxiety."

Contrary to our expectation, students in our non-computer methods courses generally reported *more positive* computer attitudes than those in an elective computer course. Since the underlying factor structure in both populations appears to be the same these differences probably cannot be attributed to factorial instability in the composite measure. Having ruled out factor instability as a source of the observed differences, the source (or sources) of the observed population differences remain unspecified. We conclude that there is a continuing need to explore computer attitude variation among teacher education students and suggest that our findings of a common 3-factor structure support meaningful comparisons across populations.

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Education students' attitudes toward the effectiveness of instructional technology

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Although the integration of all types of technology in the classroom is widely viewed as an effective instructional strategy for improving the education of students, many teachers, including preservice teachers often do not have favorable attitudes towards the potential effectiveness of technology (Huang, Copley, Williams, & Waxman, 1992; Padron, 1992). Since teachers' attitudes or dispositions toward technology have been found to influence the utilization of technology (OTA, 1988), it is important to understand teachers' attitudes toward specific types of technology or instructional technology approaches. Knowledge about attitudes towards various types of technology can assist teacher educators in providing relevant training and support to preservice teachers. This is important since teachers must not only be able to use various types of technology, but must also feel comfortable with various technology before integrating it into their daily teaching. Teacher education programs, therefore must address preservice teachers attitudes about various types of technology in order to meet the instructional needs of students by organizing instruction using the powerful tools that are currently available. The purpose of the present study was to identify education students' attitudes towards the effectiveness of various types of instructional technology that are often found in public school settings.

Methods

Subjects

The subjects in the present study were 220 teacher education students who attended an upper-division university with an enrollment of approximately 7,000 students. The university is situated near the outskirts of a large metropolitan city in the south central region of the United States. About 86% of the students were female and 14% male students. The ethnic backgrounds of the subjects were as follows: (a) White (81%), (b) Hispanic (11%), (c) Black (6%), and (d) Other (2%). The subjects were predominantly undergraduates or postbacculaurate students taking education courses for their teaching certification (84%). The amount of computer experiences for the subjects was as follows: 60.3% have used computers for 2 or more years; 19% had been using computers for one to two years; 17 have used computers less than one year; and only 3% have never used computers. Approximately two-thirds of the subjects had no teaching experience, and of the third who had been teaching, most of them only had a few years of experience.

Instrument

The *Educational Technology Survey* (Waxman, Huang, & Padron, 1991) was administered to all students in the present study. This survey identifies types and amounts of technology experiences as well as education students attitudes toward the use of technolgy. The scale which was developed specifically for the present study identified types of instructional technology that are generally found in elementary, middle, and secondary schools and assessed the extent to which the subjects thought they would be effective for improving students' education. All of the subjects responded on a six-point Likert-type scale that indicated whether they thought the technology was "Very Effective," "Effective," "Had no effect," "Ineffective," or "Very Ineffective" for improving the education of students. In addition, there was a category where students could respond if they were "not familiar" with the technology.

Procedures

All the subjects participated voluntarily and both instruments were group administered by their regular professor during their education courses at the university. The survey which took about 15 minutes to complete was administered near the end of the semester. None of the teacher education classes in which the subjects were enrolled in were technology classes.

Results

Table 1 reports the results that indicate that teacher education students felt that the most effective approach for instructional technology was having a computer lab in each high school (70.8%), middle school (63.6%), and elementary school (57.9%). The next most effective technology approach was having several computers (i.e., 4 or 5) in each high school (66%), middle school (65.1%), and elementary school (60.8%). Other instructional technology approaches like having interactive video equipment in schools and having calculators were generally not viewed as being as effective as the other approaches. In all cases, these preservice teachers indicated that technology was more effective for high schools, less effective for middle schools, and least effective in elementary schools. For example, preservice teachers reported that calculators (42.5%) and interactive

Table 1
Summary of Results

	Very Effective	No Effective	Very Effect	Not Ineffective	Ineffective	Familiar
Calculators in elementary school	14.8%	37.3	8.1	17.7	19.1	2.9
Calculators in middle school	23.1	47.6	5.3	12.0	10.1	1.9
Calculators in high school	42.5	45.4	2.4	3.4	5.3	1.0
A computer lab in each elementary school	57.9	37.3	2.4	1.0	0.5	1.0
A computer lab in each middle school	63.6	34.4	0.5	1.0	0.0	0.5
A computer lab in each high school	70.8	27.3	1.0	0.0	0.5	0.5
Interactive video equipment in each elementary school	42.3	38.9	7.7	1.4	0.5	9.1
Interactive video equipment in each middle school	47.1	38.5	4.8	0.0	0.5	9.1
Interactive video equpment in each high school.	48.8	34.3	6.3	1.0	0.5	9.2
One computer for each elementary school class	33.2	47.6	7.7	5.8	3.8	1.9
One computer for each middle school classroom	34.4	43.1	9.6	7.2	4.3	1.4
One computer for each high school classroom	36.1	41.8	9.1	6.3	5.3	1.4
Several computers (4 or 5) in each elementary school classroom	60.8	26.8	4.8	1.4	3.8	2.4
Several computers (4 or 5) in each middle school classroom	65.1	24.4	2.9	2.9	2.9	1.9
Several computers (4 or 5) in each high school classroom	66.0	23.9	3.3	1.9	2.9	1.9

video equipment (48.8%) were more effective in high school than in middle or elementary schools. Similarly, preservice teachers reported that the use of calculators (23.1%) and interactive video (47.1%) were more effective in middle schools than in elementary schools. Furthermore, the use of computer labs was cited as more effective in high school (70.8%) than in middle (63.6%) and elementary schools (57.9%); while the use of several computers in the classroom was seen by more preservice teachers as being effective in high school (66%), middle school (65.1%), and elementary school (60.8%) classrooms.

Overall, the results of the study indicated that these teacher education students had similar attitudes about having one computer in each classroom. About 80% felt that the use of one computer in each classroom was effective or very effective. On the other hand, nearly 37% reported that they thought the use of calculators in elementary school was ineffective or very ineffective. The type of technology that these education students were least familiar with was interactive video (9.1%).

Discussion

The results from the present study revealed that these teacher education students generally had positive attitudes about the use of technology for improving the education of elementary, middle, and high school students. Nonetheless, the education students surveyed found that the various types of technology are more appropriate for students at the high school level than for students in the middle and elementary school levels. In addition, preservice teachers have the least familiarity with the effectiveness of interactive video. It is important that these attitudes be addressed in teacher education programs so that the instructional needs of future teachers are met.

Future studies need to examine if these attitudes persist once most of these prospective and relatively inexperienced teachers gain more experience. Other studies also need to investigate whether experienced veteran teachers hold similar attitudes. If further studies support the present findings, then additional studies may need to investigate other plausible hypotheses that may explain if, how/or why teachers don't uniformly maintain the value of technology for improving the education of all students.

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Investigating middle school students' attitudes toward calculator use

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One of the growing concerns in the area of technology and teacher education is the need for helping teachers become aware that their students have different attitudes relating their interest and inclination toward technology. Since students' attitudes or inclination toward technology have been found to have a significant effect on their technology use, teachers should acknowledge that individual students in their classes may have differential attitudes. Knowledge of the attitudinal differences toward technology among various groups of students enables teachers to manage a learning environment in which learning is tailored to fit each student's needs and progress is based upon prescribed levels of achievement (Gubser, 1986).

Several studies have found that there are sex-related differences on students' attitudes toward computer and/or calculator usage (Arenz & Lee, 1990; Bitter & Hatfield, 1992; Collis, 1985; Dambrot, Watkins-malek, Silling, Marshall, & Garver, 1985; Gardner, 1986; Miura, 1986). Other studies have similarly found that there are grade-related and ethnic differences among students' attitudes toward technology. Jaji (1986), for example, assessed the use of calculators and computers in mathematics classes and concluded that 12th grade students had more positive attitudes toward the use of calculators and computers than had 8th grade students.

Although the use of calculators in mathematics classrooms is being widely advocated by educators and professional organizations (Hambree & Dessart, 1986; MSEB, 1990; NCTM, 1989; NRC, 1989; Willoughby, 1990), there have been very few large-scale research studies that have specifically examined students' attitudes toward calculators. The objective of the present study is to provide such information to further teacher understanding of middle school students' attitudes toward the use of calculators. More specificially this study addresses two research questions:

a) What are the middle school students' general attitudes toward the use of calculators?
b) Are there significant differences among students of different genders, grade levels, and ethnic groups in their attitudes toward calculator use?

Methods

Subjects

The participants in the present study were 5,748 middle school (i.e., Grades 6, 7, and 8) students from a multicultural school district located in a major metropolitan city in the South Central region of the United States. Of these students, 2,834 (49.3%) were male and 2,914 (50.7%) were female. A total of 1,939 (33.7%) were sixth graders, 1,953 (34%) were seventh graders, and 1,856 (32.3%) were eighth graders. The distribution by ethnic groups was fairly proportionate: 1,282 (22.3%) were

Asian, 1,355 (23.6%) were Hispanic, 1,325 (23.1%) were black and 1,786 (31.1%) were white.

Instrument

The instrument used for this study is the adapted version of SUPAI student calculator survey (Bitter & Hatfield, 1992). It consists of 23 items measuring student attitudes toward the use of calculator. It is a four-point Likert-type scale indicating student agreement with the statement (item) about calculator use. A mean value of "4" indicates that the student responded "very true" to the item, while a mean value of "1" indicates that the student responded "not at all true." The instrument has been found to be reliable and valid in previous studies. In the present study, the internal consistency reliability coefficient was found to be .79.

Procedures

All the students in the present study were issued a pocket calculator at the beginning of the school year, and all the middle school mathematics teachers in the district received at least 12 hours of inservice training on how to integrate the calculator into the current school curriculum. The survey was administered to all students during mathematics classes by experienced researchers in late October, approximately 10 weeks after they were issued the calculators.

The percentages of student agreement to the items describe the general attitude toward calculator use. For the purposes of discussion, students' responses of "very true" or "sort of true" were grouped together as well as their responses of "not very true" or "not at all true". A three-way multivariate analysis of variance (MANOVA) was used to determine the extent to which there are attitudinal differences by students' gender, grade, and ethnicity. Because of the large sample size, the probability level was set at $p < .001$ for overall MANOVA results. Both univariate analysis of variance (ANOVA) and follow-up Duncan post hoc tests were used to determine where the significant differences were.

Results

The descriptive results indicate that, in general, middle school students had favorable attitudes toward the

Table 1
Student Attitudes Toward Calculator Use in Percentage

Item	Very True / Sort of True	Not Very True / Not at all True
1. I feel smarter when I use a calculator.	61%	39%
2. Students should not be allowed to use a calculator while taking math tests.	42%	58%
3. The calculator will cause me to forget basic arithmetic facts.	38%	61%
4. Calculators make mathematics fun.	80%	19%
5. When I work with a calculator, I do not need to show my work on paper.	52%	48%
6. Math is easier if a calculator is used to solve problems.	86%	14%
7. I understand math better if I solve problems with paper and pencil.	65%	35%
8. I know how to use a calculator very well.	89%	11%
9. It is important that everyone learn how to use calculators.	84%	16%
10 .I do better in math when I use a calculator.	77%	23%
11. I prefer working word problems with a calculator.	67%	33%
12. Using a calculator makes me try harder in math.	43%	57%
13. Using a calculator to solve money problems is confusing.	25%	75%
14. Calculators should be used only to check work once the problem has been worked out on paper.	50%	50%
15. Calculators are not useful for solving fraction problems.	30%	70%
16. I feel calculators should be used on math homework.	73%	26%
17. Using a calculator will cause me to forget how to do basic computation skills.	36%	64%
18. The calculator makes me a better problem solver.	58%	42%
19. If I continue to use a calculator, my estimation skill will decrease.	37%	63%
20. My parents do not like me to use a calculator for my math work.	42%	58%
21. Using a calculator does not help me with my math work.	22%	78%
22. In my math class, I know when I can and cannot use my calculator.	84%	16%
23. I have difficulty reading the calculator screen.	13%	87%

Table 2
Main Effects of Gender on Student Calculator Attitudes

	Male		Female		
	(n = 2834)		(n = 2914)		
Item	M	SD	M	SD	F
1. I feel smarter when I use a calculator.	2.68	1.05	2.64	0.98	2.38
2. Students should not be allowed to use a calculator while taking math tests.	2.29	1.21	2.22	1.18	4.06
3. The calculator will cause me to forget basic arithmetic facts.	2.17	1.08	2.11	1.04	3.81
4. Calculators make mathematics fun.	3.17	0.97	3.25	0.87	9.46
5. When I work with a calculator, I do not need to show my work on paper.	2.54	1.19	2.55	1.14	0.17
6. Math is easier if a calculator is used to solve problems.	3.42	0.84	3.39	0.82	2.58
7. I understand math better if I solve problems with paper and pencil.	2.83	1.06	2.84	0.99	0.69
8. I know how to use a calculator very well.	3.36	0.76	3.33	0.72	3.88
9. It is important that everyone learn how to use calculators.	3.32	0.89	3.39	0.82	10.11
10. I do better in math when I use a calculator.	3.11	0.94	3.08	0.89	2.17
11. I prefer working word problems with a calculator.	2.85	1.05	2.90	1.01	3.10
12. Using a calculator makes me try harder in math.	2.28	1.08	2.34	1.05	3.37
13. Using a calculator to solve money problems is confusing.	1.87	1.02	1.78	0.96	12.44*
14. Calculators should be used only to check work once the problem has been worked out on paper.	2.52	1.12	2.53	1.10	1.43
15. Calculators are not useful for solving fraction problems.	2.01	1.11	1.93	1.07	7.39
16. I feel calculators should be used on math homework.	3.04	1.04	3.06	0.99	0.29
17. Using a calculator will cause me to forget how to do basic computation skills.	2.13	1.05	2.11	1.02	0.26
18. The calculator makes me a better problem solver.	2.67	1.06	2.63	0.98	1.75
19. If I continue to use a calculator, my estimation skill will decrease.	2.80	1.08	2.85	1.01	2.22
20. My parents do not like me to use a calculator for my math work.	2.29	1.19	2.16	1.16	13.82*
21. Using a calculator does not help me with my math work.	1.82	1.04	1.68	0.96	25.77*
22. In my math class, I know when I can and cannot use my calculator.	3.30	0.97	3.47	0.86	52.15*
23. I have difficulty reading the calculator screen.	1.50	0.89	1.34	0.73	59.45*

* $p < 0.001$

use of calculators. Table 1 reports the students' attitudes toward calculator use in percentage. Over 80% of the students responded "very true" or "sort of true" that (a) they know how and when to use calculator, (b) it is important that everyone learns how to use calculator, (c) calculators make mathematics fun, and (d) mathematics is easier if a calculator is used to solve problems. About three-quarters of the students responded that they did better in mathematics when they used calculators and that they felt calculators should be used in mathematics homework. However, only slightly over 40% of the students responded that using a calculator made them try harder in mathematics. About 40% of the students responded that students should not be allowed to use a calculator while taking mathematics tests, and that the calculator would cause them to forget basic arithmetic facts or decrease their estimation skills. About an equal number of students responded that their parents did not like them to use calculator for their mathematics work. Half of the students indicated that calculators should be used only to check work once the problem had been worked out on paper. As high as 65% of the students indicated that they understood better if they solved problems with paper and pencil.

The three-way MANOVA results revealed overall significant differences in students' attitudes attributable to gender (F(23, 5712) = 7.61, p<.001), grade (F(46, 11404)=24.00, p<.001), ethnicity (F(69, 17035.39)=8.30, p<.001), and the interaction of grade and ethnicity (F(138, 33255.89) = 1.63, p<.001). As a follow-up procedure, univariate ANOVAs and Duncan multiple comparison tests were used to determine where the differences are.

Table 2 reports the main effect of gender on student calculator attitudes. The results reveal that the girls generally felt more positive about the use of calculator than the boys. Fewer girls than boys felt that using calculators was not helpful. Girls had less difficulty reading the calculator screen, and their parents were less likely to disapprove of their using calculators for mathematics work.

Girls were more certain of when they can use calculators in mathematics classes. Boys showed a greater variation in responses.

Further ANOVA results indicate that the interaction effects of gender and ethnicity were found in students' responses to (a) item 4: calculators make mathematics fun (F=3.02, p<.01), (b) item 16: I feel calculators should be used on math homework (F=3.07, p<.01), and (c) item 23: I have difficulty reading the calculator screen (F=2.82, p<.01). Table 3 compares the means of calculator attitudes among students from various ethnic groups within the same grade level on items of significant differences. Within the sixth and eighth grade levels, Asian students were less likely to respond that calculator make mathematics fun than students from other ethnic groups. With each grade level, fewer Asian students felt that calculator should be used on math homework than other students, whereas more Hispanic students responded that they had difficulty reading the calculator screen than other students. Black sixth grade students were also more likely to have difficulty reading the calculator screen.

Discussion

The results of the present study support previous research findings that while students generally hold positive attitudes toward the use of calculators, they simultaneously express concerns about the possible negative effect of using calculators. To enhance high level

Table 3
Differences in Calculator Attitude among Students from Various Ethnic Groups within the same Grade Level

D.V.: Calculators make mathematics fun.

		Asian	Hispanic	Black	White	F
6th Grade	M	3.04a	3.23b	3.23b	3.36c	9.58*
	SD	0.97	0.94	1.00	0.86	
7th Grade	M	3.19a	3.26a	3.31a	3.30a	1.79
	SD	0.86	0.88	0.92	0.85	
8th Grade	M	2.90a	3.18b	3.26b	3.15b	12.46*
	SD	0.98	0.92	0.91	0.92	

D.V.: I feel calculator should be used on math homework.

		Asian	Hispanic	Black	White	F
6th Grade	M	2.49a	2.99c	2.80bc	2.94b	18.58*
	SD	1.10	1.04	1.11	1.06	
7th Grade	M	2.94a	3.15b	3.08b	3.19b	6.04*
	SD	0.99	0.98	0.98	0.94	
8th Grade	M	3.02a	3.20b	3.26b	3.42c	16.07*
	SD	1.01	0.93	0.92	0.82	

D.V.: I have difficulty reading the calculator screen.

		Asian	Hispanic	Black	White	F
6th Grade	M	1.36a	1.55b	1.55b	1.34a	9.85*
	SD	0.78	0.92	0.89	0.73	
7th Grade	M	1.35a	1.50b	1.38a	1.37a	3.29
	SD	0.78	0.86	0.79	0.78	
8th Grade	M	1.42a	1.58b	1.35a	1.33a	8.48*
	SD	0.81	0.93	0.78	0.74	

* $p < .001$

Note: Mean values with the same letter are not significantly different from each other.

and critical thinking, middle school mathematics teachers may need to reassure their students of the appropriate use of calculators. To do so, the teacher themselves will need an understanding of how to best integrate calculators in their classroom instruction. Teacher educators should adequately prepare teachers with such an understanding and training. The results of the present study further suggest that demographic characteristics such as gender, grade, and ethnicity differentially influence students' attitudes toward the use of calculators. Since both male and female students' attitudes toward calculators have been found to be positively associated with their mathematics performance (Munger & Loyd, 1989), it is important to investigate students' attitudes and the factors that may affect their attitudes when integrating calculator use in the mathematics. While middle school students were generally found to have positive attitudes toward calculator use, girls' attitudes were significantly more favorable. This finding is consistent with previous studies that compared seventh and eighth grade boys' and girls' attitudes after calculators were introduced to their mathematics classes (Bitter & Hatfield, 1992).

Students from different ethnic groups demonstrated significantly different attitudes toward various aspects of calculator use, particularly in the sixth and eighth grades. These findings raise several plausible explanations that need further investigation. Asian middle school students, for example, may be more confident than other students in mathematics and consequently less dependent on calculators. Hispanic students, on the other hand, may be less technology oriented than other students, and consequently have difficulty reading the calculator screen. The underlying factors of these and the other significant differences found in the present study deserve further investigation. Nonetheless, findings of this large scale research study have provided in depth a demographic composite of variables and their interactions on students' attitudes toward the use of calculators. Mathematics teachers may keep in mind the individual differences in students' indications toward technology use and adjust their teaching strategies accordingly. To increase the application of the attitudinal study future research may want to examine the relationship between: (a) students' attitudes and their actual use of calculators, and (b) students' and teachers' attitudes toward calculators.

Acknowledgement

This research is supported in part by the Department of Education, Dwight D. Eisenhower Mathematics and Science Education Program, award number168D00311. The opinions and views presented in this paper do not necessarily reflect those of the granting agency.

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Classroom observations of middle school students' technology use in mathematics

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In the last two decades there has been a great deal of research that has employed systematic classroom observation techniques to investigate effective teaching at the elementary, middle, and high school levels (Brophy & Good, 1986; Evertson & Green, 1986; Galton, 1988). Although there have been several criticisms and cautions related to the use of structured observation techniques (Evertson & Green, 1986; Galton, 1988), several researchers have demonstrated how the use of observational techniques can improve teachers' classroom instruction (Stallings & Freiberg, 1991; Stallings, Needels, & Stayrook , 1979). One important area, however, that has not been widely investigated within the study of classroom observation is that of examining how systematic observations can help us understand the academic problems of individual students or individual groups of students. Most classroom observation research has either focused on teacher behaviors or general classroom behavior, and very little research has been specifically targeted at the classroom behaviors of individual students. This has been especially true in the area of technology, where studies often use survey reports to assess technology use in schools (Cohen & Fliess, 1979; Pagni, 1991; Terranova, 1990). Since there are many criticisms of self-reported assessments of technology use, it is important to observe the actual extent to which technology is used in classrooms and specifically look at the technology use of individual students because it may differentiate the academic success or failure of these students.

There have been a few studies that have used classroom observation to investigate technology use in multiethnic settings (Copley & Williams, 1992; Williams, Copley, Huang, & Bright, 1993), but these studies have not specifically examined differences among individuals or groups of students on the amount of time they use technology in their classes. Furthermore, many of the studies observing technology use have been generic (i.e., generalizing across grade levels and content areas), rather than specifically focused on a given subject and/or grade level (Gage, 1985, Gage & Needels, 1989; Needels & Gage, 1991).

The objective of the present study is to systematically observe the technology used in mathematics by middle school students from different ethnic groups, genders, and grade levels. More specifically, this study examines whether there are significant differences between middle school boys and girls of various ethnic groups and grade levels on their technology use observed in the classroom.

Methods

Subjects

The subjects in the present study were 1,315 middle school students from a multiethnic school district located within the vicinity of a major metropolitan city in the South Central region of the United States. The school district was selected because it had recently been awarded a grant from the Department of Education involving the integration of calculators in mathematics instruction. A great majority of the students were from lower-middle to upper- middle class families. They represented a better than average national achievement level. The gender distribution among these students was nearly equal: 49.4% female and 50.6% male. About 32% of the students observed were white, 26% were black, 20% were Hispanic, and 23% were Asian. About 38% of the students were sixth graders, 32% were seventh graders, and 30% eighth graders.

Instrument

The instrument used in the present study was a modified version of the Classroom Observation Schedule (COS) (Waxman, Wang, Lindvall, & Anderson, 1983). The COS is a systematic observation schedule designed to document observed student behaviors in the context of ongoing classroom instructional-learning processes. Individual students are observed with reference to (a) their interactions with teachers and/or peers and the purpose of such interactions, (b) the settings in which observed behaviors occur, (c) the types of material with which they are working, and (d) the specific types of activities in which they engage. For the present study, the type of technology used was added to the observation schedule and was the only scale used. Four indicators were used to measure the percentage of time that any calculator or computer was used. The median interater reliability (Cohen's Kappa) of this scale was found to be .98.

Procedures

Prior to the observation, all mathematics teachers had 12 hours of training in calculator use, and each student was issued a hand-on calculator. The observations were conducted in mathematics classes in the spring semester by trained observers. Both teachers and students were not notified of the purpose of observation. Arrangements were made to observe regular classroom processes; classes devoted to special activities (e.g., standardized tests, quizzes, etc.) were avoided. Stratified sampling techniques (i.e., gender and ethnicity) were used so that approximately six students from each class were randomly chosen to be included in the sample. Each student was observed for ten intervals (each interval was 30 seconds) during the approximately 50 minute data-collection period. A three-way multivariate analysis of variance (MANOVA) was used to determine if there were any statistically significant differences among students of various grade levels, genders, and ethnic groups on the amount of time they used a specific type of technology. Because of the large sample size and the great variance between observations, the probability level was set at .01.

Results

The descriptive results indicate that on average calculators were used in mathematics about 25% of the time. Both the overhead projector calculators and computers that were used were observed less than 0.1% of the time, and no technology was used about 75% of the time. Of the 1,315 students observed, about 54% never used calculators, 22% used calculators over half of the time, and 9% of them used calculators all the time.

The MANOVA results indicated an overall significant multivariate effect for grade level on students' use of technology in the middle school mathematics class (F(8, 2576) = 3.63, p<.001). Follow-up univariate analysis of variance (ANOVA) revealed that the differences were found in the categories of "calculators" and "no technology". Table 1 reports the descriptive and univariate

Table 1
Descriptive and Univariate ANOVA Result of Technology Used by Students of Different Grade Levels, Ethnic Groups, and Gender.

By Grade

	6th grade (n=495)		7th grade (n=422)		8th grade (n=398)		
Item	**M**	**SD**	**M**	**SD**	**M**	**SD**	***F***
1. Calculator	22.99	32.54	29.71	37.51	20.86	32.41	8.16*
2. Overhead projector calculator	0	0	0.12	1.21	0	0	4.04
3. Computer	0.15	2.10	0	0	0	0	1.93
4. No technology	76.88	32.54	70.20	37.51	79.20	32.33	8.33*

* $p<.001$

By Ethnicity

	White (n=419)		Black (n=336)		Hispanic (n=255)		Asian (n=305)		
Item	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	***F***
1. Calculator	24.87	34.87	22.84	32.86	24.96	35.56	25.44	34.30	.41
2. Overhead projector calculator	0.06	0.86	0	0	0.05	0.78	0.04	0.72	.52
3. Computer	0.09	1.83	0	0	0	0	0.12	1.60	.63
4. No technology	75.01	34.88	77.16	32.86	74.99	35.55	74.51	34.20	.43

By Gender

	Male (n=666)		Female (n=649)		
Item	**M**	**SD**	**M**	**SD**	***F***
1. Calculator	24.07	33.95	24.93	34.77	.17
2. Overhead projector calculator	0.02	0.48	0.06	0.85	1.46
3. Computer	0.11	1.81	0	0	1.81
4. No technology	75.84	33.93	75.02	34.75	.17

ANOVA results of technology used by students of different grade levels, ethnic groups, and genders.

Seventh grade students were observed using calculators significantly more frequently than sixth or eighth grades (F= 8.16, p<.001). Consequently, they were observed less frequently not using technology (F= 8.33, p<.001) than students from other grades.

Although the differences were small and not statistically significant, Asian students were observed more frequently using calculators and computers than students from other ethnic groups. Black students were observed using all categories of technology less frequently than other ethnic groups. Girls were observed using calculators slightly more than boys, but only boys were observed using computers.

Discussion

The results of this study found that the computer was seldom utilized in mathematics classrooms. The very low percentage of use suggests that integrating technology in middle school mathematics classrooms has fallen short in some areas. Previous studies on computer use often measured the effects of special interventions (Nicholson & Wahl, 1988; Reglin, 1988). The present study which observed regular classroom interactions may provide a much more realistic assessment of what actually occurs in multiethnic, metropolitan school districts. Traditionally computer and calculator uses were considered to be effective in the improvement of teaching and learning in mathematics and science (Bitter & Hatfield, 1992; Funk, 1987; Hembree & Dessart, 1986). The very low percentage of computer and other technology use raises some concern. Barriers to computer and other technology use such as the requirement of computer expertise, difficulties with whole-class demonstration format and so forth need to be identified and overcome (Russek & Weinberg, 1991). Similar to the calculator use, the availability of computers in each classroom and teacher in-service training of how to implement computers in classroom instruction may be part of the solution to enhance computer utilization in education.

Students' use of calculators was boasted by the provision of a free calculator for each student and teacher in-service training. Students used calculators about one quarter of the time they were observed. Seventh grade students, however, were observed using calculator activities significantly more than students from other grades. Some of the possible explanations for the grade differences may include mathematics content, teacher and student attitudes, and other factors.

Several prior research studies have reported differences between secondary school boys' and girls' use of technology and the reasons for the differences (Anderson, 1983; Arenz & Lee, 1990; Culley, 1988; Funk, 1987; Miura, 1986; Nielsen & Roepstorff, 1985; Voogt, 1987). Contrary to these previous findings, the present study found no statistically significant differences by gender on students' use of technology.

Students' ethnic group has been found to be related to the variance of their mathematics achievement (ETS, 1988), but the present study found that there were no differences among ethnic groups on the amount of students' use of technology. Since the present classroom observation study focuses on the quantity of technology used by middle school students in mathematics classes, additional observational data examining how the specific technology is used by students as well as by teachers may provide an insight to the quality of technology use.

Acknowledgement

This research is supported in part by the Department of Education, Dwight D. Eisenhower Mathematics and Science Education Program, award number 168D00311. The opinions and views presented in this paper do not necessarily reflect those of the granting agency.

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Investigating computer use in elementary and middle school inner-city classrooms

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Introduction

In recent years, there have been a large number of studies that have examined the use of technology in schools (Becker, 1986; Plomp & Pelgrum, 1991; Ross, 1991). Some studies have been generic in nature and have reported broad findings that are meant to be generalized either across the country, region of the country, or a given state. Other studies have been somewhat more specific, assessing technology use in particular districts or individual schools, but these studies generally do not examine the extent to which computer technology is integrated in the curriculum and used in individual classrooms.

Another current criticism of the research on technology use in schools is related to the measurement of "technology use." Many studies assessing technology use have relied on self-report data from administrators and/or teachers. These type of data, however, are often unreliable and tend to be upwardly biased in the direction of over reporting the actual amount technology use. Since there are many criticisms of self-reported assessments of technology use it is important to observe the actual extent to which technology is used in schools and more specifically look at how computer technology is integrated in individual classrooms.

There have been a few studies that have used classroom observation to investigate technology use in multiethnic settings (Copley & Williams, 1992; Williams, Copley, Huang, & Bright, 1993), but again these studies have not specifically examined the extent to which computers are integrated in individual classrooms across grade levels and content areas. Furthermore, they have not systematically observed technology use in classrooms from inner-city, urban schools, where the highest percentage of students at risk of failure are found (Boyd, 1991; Hodgkinson, 1991). Nowhere are the social implications of increasing numbers of disadvantaged families in inner cities more prevalent than in the large, urban school districts where the deletorious conditions of underachievement, student and teacher alienation, and high drop-out rates exist. Furthermore, many of the physical structures and facilities in inner-city schools are abysmal and in desperate need of rehabilitation (Piccigallo, 1989).

Although there is some evidence that suggests that technology can enhance the education of students from urban, at-risk school environments (Office of Technology Assessment, 1988; Olsen, 1990), several educators argue that the use of technology in the schools will create even greater disparities by actually widening the gaps between minority and non-minority students (Apple, 1988, 1991; Cummins & Sayers, 1988; Johnson & Maddux, 1991). Elementary and secondary students from higher-income families, for example, are more likely to use computers in school and in their homes than students from lower-income families (Cole & Griffin, 1987; Sutton, 1991; U.S. Department of Education, 1991). Minority students in urban schools have been found to have less access to computers than students from suburban districts (Office of Technology Assessment, 1988; Picciano, 1991; Picciano & Kinsler, 1991; Sutton, 1991). Likewise, there is evidence that there are differences in how computers are used in schools with predominantly minority students. In those schools, students typically work on tutorial and rote drill-and-practice programs, while schools with students from higher-income families generally use computers for problem solving and programming (Cole & Griffin, 1987; Office of Technology Assessment, 1988). While there is some evidence that this trend may be changing (Picciano, 1991; Picciano & Kinsler, 1991), this general problem of computer use in inner-city classrooms is one that needs to be seriously addressed. Consequently, the objective of the present study is to systematically observe the extent to which computer technology is used in elementary and middle school, inner-city classrooms.

Methods

Subjects

Two hundred classrooms from a large urban school district located in the South Central area of the United States, were randomly selected to be included in the study. This urban school district is one of the largest in the country and over 70% of all students in the district are ethnic minorities. A total of approximately eight third, fourth, and fifth grade classes were selected from each of the 16 elementary schools in the sample, while about six sixth and eighth grade classrooms were randomly selected from the 12 middle schools. There were a total of 116 elementary and 84 middle school classrooms in the study.

Instrument

The Computer Usage Scale (CUS) was developed specifically for the present study and was used to assess the amount of time computers were used in the classroom and how the computer was used. Each observer was trained individually to use the (CUS) and the inter-rater reliability for the scale was found to be greater than .80.

The CUS is a high-inference scale that the classroom observer completes after observing the class for approximately 40 minutes. The rating scale is an estimate of how much time each of the items related to computer use were observed during the observation period. The CUS includes items such as (a) the number of computers in the classroom, (b) the amount of time students spent working with computers, (c) the amount of time the teacher used the computer as part of classroom instruction, and (d) the amount of time students used computers for activities like drill-and-practice, problem solving, games, writing, mathematics, and science.

Procedures

Each teacher was observed using the CUS on two separate occassions during a four-week period near the end of the school year. The observations lasted approximately 40 minutes each time and were scheduled for the same class period (time of day) for each observation. There were no restrictions placed on the teachers regarding subject or content area and we were therefore able to observe teachers providing instruction in all major content areas.

Results and Discussion

Table 1 reports the observational results by type of school. One computer was found in each of the elementary school classrooms observed ($M = 1.0$). There was an average of slightly over one computers in each of the middle school classrooms ($M = 1.1$), but the number varied from one to as many as six computers in one classroom. Computers were not observed being used in elementary school classes and they were observed only 2% of the time in middle school classes. Elementary school students were not observed using computers for any type of computer activities, while middle school students were observed using computers for (a) problem solving (1.5%), (b) writing activities (.9%), and (c) games (.9%). In middle school classrooms, teachers were observed using the computer as part of their classroom instruction less than 1% of the time (.9%), while elementary school teachers were *never* observed using the computer as part of their classroom instruction.

The findings of the present study suggest that computers are not being integrated into the delivery of instruction in this inner-city school district. This is especially problemmatic given that there is some growing evidence that suggests that technology can significantly improve the education of students in urban schools. Olsen (1990), for example, found that integrated learning systems significantly improved the academic achievement of minority students from several minority school districts across the country. This integrated learning system included (a) computerized, criterion-referenced tests that allowed for individualized assessment, (b) courseware providing interactive practice and feedback and covering basic skills, higher-order thinking, and problem solving, and (c) an instructional management system that allowed teachers to monitor and track students' progress.

Although the present study provides evidence that there is a lack of computer integration in the elementary and middle school curriculum of this urban school district, the problems identified here are not unique to this particular district. Several studies, for example, have similarly found that computers in schools are rarely used for subjects like reading, mathematics, or science, but are

Table 1
Summary of Computer Use and Type of Computer Activities

	Elementary School (n = 116)	Middle School (n = 84)
Computer Use		
1. Number of computers in the classroom	1.0	1.1
2. Amount of class time students spent working with computers	0%	2.1%
Types of Computer Activities		
3. Teacher uses computers as part of classroom instruction	0%	0.9%
4. Students use computers for drill and practice	0	1.2
5. Students use computers for problem solving	0	1.5
6. Students use computers for games	0	0.9
7. Students use computers for writing activities	0	0.9
8. Students use computers for math activities	0	0
9. Students use computers for science activities	0	0
10. Students use computers for other activities	0	0

generally used exclusively for learning about computers themselves (Office of Technology Assessment, 1988).

Despite the well-known potential of instructional technology to improve the cognitive and affective outcomes of students, only a very small number of teachers in present study were integrating technology in the curriculum. These findings suggest that the process of integrating instructional technology into content areas is still in its early stages. Effective integration of instructional technology in the curriculum is a complex process that will require restructuring of schools and classrooms. Future research may need to examine factors that may contribute to the lack of integration, such as acquiring more computers, training teachers to use computers, selecting software, and integrating software into the curriculum.

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Technology access and use in urban, suburban, and rural Eighth Grade mathematics classrooms

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Many educators and professional organizations are advocating that both calculators and computers need to be widely used and integrated into the middle school mathematics curriculum (MSEB, 1990; NCTM, 1989; NRC, 1989; Willoughby, 1990). Although many informal reports and status studies indicate that technology use is increasing in schools, there have been very few large-scale, national studies that have actually examined how calculators and computers are used in middle school mathematics classrooms. Another important issue related to technology use is whether or not students from different types of schools have equal access to the technology and use of technology similarly. Several studies, for example have found that there are differences between urban and suburban schools on the access and use of computers. Most of these studies, however, have been relatively small scale studies comparing one urban district to a suburban district. Large scale systematic studies are needed to replicate these previous studies.

The purpose of the present study is to examine the access and use of technology in mathematics at the middle school level. Moreover, this study compares technology access and use in schools from three different community settings: (a) urban, (b) suburban, and (c) rural schools.

Methods

Data for this study were drawn from the eighth grade cohort of the National Educational Longitudinal Survey of 1988 (NELS:88). The NELS:88 survey design covered a two-stage, stratified national probability sample. About 24,599 eighth graders, enrolled in 1,052 public and private schools across the nation, participated in the 1988 base-year survey, which examined the school-related experiences and accomplishments of eighth grade students, their parents, and their teachers, along with information on their schools. For the present study, the teacher was the basic unit of analysis. NELS:88, surveyed eighth grade teachers, focusing on their educational background, teaching experiences, and classroom behaviors. Information about technology access and technology use were also included in the teacher survey. For the present study, 3,825 teachers were randomly selected from a sampling of about 6,000 eighth grade, mathematics teachers. About 40% of the teachers were categorized as being from suburban schools, while 30% were from urban schools, and 30% were from rural school settings.

Results

Table 1 reports overall results which indicate that about 51% of the eighth grade mathematics teachers reported that students did not have access to calculators.

About 53% of the teachers reported that they hardly ever or never used calculators in their classroom. For those teachers using calculators, the results indicated that 26% used them several times a week. The remaining 21% of the teachers reported using calculators at least once a week.

About 52% of the teachers reported that less than 10% of their students were using computers. About 20% of the teachers reported greater than 90% of their students used computers. The results for computer use found that the majority of teachers in the present study (33%) used computers for enrichment purposes only. This was followed by teachers using the computer for enrichment and remediation. The lowest usage of computers was for remediation only (2.8%).

Table 2 reports the results by location of school. Teachers from suburban schools reported that about 50% of their students had access to calculators, while nearly 49% of the teachers from urban and rural schools reported that their students that have access to calculators. About 32% of the suburban teachers reported that they used calculators several times a week, while only 21% of the urban teachers of 20% of the rural teachers reported they used calculators several times a week. The results also revealed that 64% of the rural teachers hardly ever or never used calculators, while the percentage of urban and suburban teachers that reported hardly ever or never using calculators was 55% and 46% respectively.

The results indicated that 66% of the rural teachers reported that less than 10% of their students were using computers. The results also indicated that 48% of the urban teachers and 47% of the suburban teachers reported that less than 10% of their students used computers. About 25% of the urban school teachers and 22% of the rural teachers reported that more than 90% of their students were using computers, but only 10% of the rural teachers reported that more than 90% of their students were using computers. Rural and suburban teachers were most likely to report that their students used computers for enrichment, while urban teachers were more likely to report their computers being used for mainly remediation than suburban and rural teachers.

Discussion

The results of the present study suggest that there are important differences on the access and use of technology in eighth grade mathematics classrooms by type of school community. Rural teachers reported that they were less likely to use technology than teachers from suburban and urban schools. Urban teachers also reported that their

Table 1
Overall Summary of Technology Use

Access to Calculators	
Yes	49.3%
No	50.7
How often calculators are used	
Several times a week	25.7%
Once a week	21.2
Hardly ever	53.1
Percentage of students using computer	
Less than 10%	52.4%
10% to 25%	15.9
26% to 50%	7.6
51% to 75%	2.8
76% to 90%	1.6
Greater than 91%	19.8
How computers are used for instruction	
Total enrichment	33.4%
Mainly enrichment	21.5
Enrichment & Remediation	27.8
Mainly Remediation	14.5
Remediation	2.8

Table 2
Overall Summary of Technology Use by Location

	Urban	Suburban	Rural
Access to Calculators			
Yes	48.6%	50.0	48.9
No	51.4	50.0	51.1
How often calculators are used			
Several times a week	21.3%	31.8	19.6
Once a week	23.6	22.7	16.3
Hardly ever	55.1	45.5	64.2
Percentage of students using computers			
Less than 10%	48.0	47.3	65.5
10% to 25%	15.3	15.6	17.0
26% to 50%	8.8	9.3	3.4
51% to 75%	2.5	2.7	3.1
76% to 90%	0.4	2.7	0.8
Greater than 91%	24.9	22.4	10.2
How computers are used for instruction			
Total enrichment	27.3%	34.6	37.5
Mainly enrichment	22.3	21.2	21.3
Enrichment & Remediation	25.9	27.9	29.5
Mainly Remediation	22.6	13.7	7.7
Remediation	2.0	2.7	4.0

students were more likely to use computers for *remediation* than suburban and rural teachers.

Another important finding from this study relates to the descriptive results that summarize students' overall access to calculators and computers. The results from the present study suggest that overall these eighth grade students do not great access to either calculators or computers in mathematics classes. Thus, the findings from this study are in opposition to some educators who argue that access and use of technology is not one of our most critical educational problems.

Although the findings in the present study suggest several differences in the extent students have access and use technology, further observational research is needed to verify these results. Other research questions that still need to be investigated in this area include examining (a) the ideal or optimum levels of technology access and use that should exist in eighth grade mathematics classrooms, (b) whether there are other contextual variables like type of school (e.g., public or private) or state policies that influence access and use of technology, (c) if family characteristics such as socioeconomic status influence the access and use of technology, and (d) what other variables or factors differentiate high- and low access and use of technology. Future studies should also attempt to examine specific geographic locations or settings, especially urban settings where many more students are at risk of dropping out and not furthering their education.

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Instruction with technology: Differences between experienced and novice teachers

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Researchers have found that experienced and novice teachers often plan and behave differently. Of more importance, it is hypothesized that these differences can be identified and used to improve the teaching of novices. Although there are numerous studies on expert teachers, few have investigated the instructional differences between veteran and novice teachers when technology (i.e., calculators) is present.

Studies of effective teaching have identified several factors which differentiate expert teachers from novice teachers. Leinhardt and Greeno (1986), for example, identified planning as a major area of difference. They found that experts do not form detailed plans; in fact, planning and adjustments are carried over into the actual lesson. Clark and Lampert (1988) noted that details such as timing, pacing, and exact number of examples and problems are not included in the plans of experts. These aspects are decided upon as a reaction to student performance. Novices often rely on their detailed plans and become flustered when responses to needs and questions of students disrupt this planned sequence (Livingston & Borko, 1989). Experts, in contrast, are able to keep direction in the lesson, diverge during teachable moments, and return to their objectives (Institute for Research on Teaching, 1986).

Carter (1988) suggested several ways in which content knowledge problems along with pedagogical problems identify differences between novice and expert behavior. Teachers who are weak in content knowledge often fail to emphasize the processes and interpretation, and thus focus mainly on the correct answer or recall of facts (Clarridge, 1990). Effective teachers determine student prior knowledge, assess understanding, and identify misconceptions or "bugs" (Feiman-Nemser & Buchmann, 1989).

Other effective teaching strategies include focusing attention, guiding, questioning, and managing. Experienced teachers use activities to draw students into overt involvement; novices often encourage passive learning by discouraging questions and avoiding divergence from the planned lesson (Leinhardt & Greeno, 1986). Leinhardt and Greeno also found that experts monitor at least two practice problems before independent work is assigned; novices often move straight from presentation to independent practice. They also found that novices are more sensitive to student behaviors that interrupt their presentations than to cues and questions from students. Clarridge (1990) recognized that expert teachers anticipate problems and keep students on task through activities and monitoring.

The purpose of the present study is to investigate the following: (a) differences between experienced and novice teachers in the ways in which they instruct and interact with students particularly when technology (i.e., calculators) is used, (b) differences observed in student activities in classrooms of experienced and novice teachers when calculators are present, and (c) differences between the amount of student calculator use in experienced and novice teachers' classrooms.

Methods

Two groups of middle school mathematics teachers who differed in experience and expertise participated in the present study. These teachers and their students are part of a nationally funded project involving the development of calculator mathematics curriculum and the implementation of calculators in a large, urban/suburban school district located in a major metropolitan city in the south central region of the United States. Each middle school mathematics teacher in the district received a minimum of 12 hours of inservice training on the use of calculators, and each of their students was issued a calculator. Sixty middle school teachers were involved in the project.

Schools within this district have been identified as National Exemplary Schools and have been recognized for their many innovative programs. Teachers within the district are encouraged and provided with support for continued training and education. For the most part, the teachers appear to believe that their administration supports their efforts in the classroom. As a result, there are many teachers who have elected to remain in the district for most of their teaching careers. In 1991, approximately 40% of the district teachers had taught 0 to 5 years, 20% had taught 6 to 10 years, and 40% had taught for 10 or more years.

A group of experienced teachers and a group of novice teachers were identified in the present study by a panel of four experienced mathematics educators: (a) the district mathematics coordinator, (b) the principal investigator of the project (a former mathematics supervisor for the district), (c) the project director who had worked with the teachers and conducted classroom observations in their classrooms the prior year, and (d) a state-certified assessor who had done extensive classroom observations within the district middle schools. Factors included in the experience and expertise criteria were: (a) number of years teaching experience, (b) highest degree held, (c) strength of mathematics and/or mathematics education background, (d) involvement in professional development, (e) participation in the curriculum development project, and (f) classroom teaching expertise. It should be noted that a broader definition of "expert teacher" has been applied in the selection process and thus explains why the term "experienced teacher" has been utilized for this study.

Twenty-eight teachers (14 experienced and 14 novice) were selected. The novice teachers were selected from the 40% who had taught between 0 and 5 years. The experienced teachers were selected from the approximately 42% who had taught 10 years or more; their experience ranged from 10 to 22 years. Eight members of the experienced group held elementary certification with specializations in mathematics; the other six were secondary certified and had majors in mathematics. Twelve of the members of the experienced group had masters degrees; the other two are nearing completion of their masters programs. Eight of the novices were elementary certified but had not specialized in mathematics; the other six were secondary certified but had limited mathematics background. The highest degree earned by the members of the novice group was a bachelors degree.

The data collected for this study was obtained during the second year of the project. Each teacher was observed six times during the school year by trained classroom observers. Teachers had no indication as to when they would be observed. Two observations for each teacher were completed in October and November, two in January and February, and two in April and May. There were a total of 84 45-minute observations of novice teachers, and 84 45-minute observations of experienced teachers. Two instruments were used for the observations: (a) the Observation Rating Scale for Features of Adaptive Instruction (ORSFAI) (Waxman, Wang, Lindvall, & Anderson, 1983), and (b) the Observation Rating Scale for Calculator Implementation (ORSCI) (Williams, Waxman, & Copley, 1991).

The ORSFAI is a high-inference instrument which assesses eight major scales: Instructional Materials, Instructional Activities, Classroom Management, Set Induction, Content Focus, Teacher Questioning, Emphasis on Higher-Level Thinking, and Classroom Environment. The eight scales consist of 43 indicators, approximately five indicators for each scale. The Classroom Management indicators, for example, include: (a) efficient class organization, (b) effective time management, (c) clear communication of activity procedure, (d) student awareness of classroom procedures and rules, (e) few interruptions due to behavior problems, and (f) student attention immediately refocused on activity when interruptions do occur. The ORSFAI has been found to be reliable and valid for use in classroom observations of teacher and student behaviors (Waxman, 1984). The interrater reliability for the instrument was found to be 0.90 in the present study.

The ORSCI is a high-inference instrument which (a) assesses the quality of the calculator instruction (Scale A), (b) measures the amount of calculator use in each classroom (Scale B), and (c) identifies the kinds of activities in which students are involved when they use calculators (Scale C). Scale B was not included in some of the analyses because it assesses only percentage of students who have calculators at their desks or table and the amount of time students (who have calculators) use them. Seventeen indicators measure the quantity and quality of calculator instruction and use. The interrater reliability for the instrument was found to be .94.

Observation data were analyzed at the teacher level for possible differences between the independent variable (i.e., two groups). The dependent variables included eight scales from the ORSFAI instrument and two scales from the ORSCI instrument. The ten scales analyzed for this study were: (a) measures of teacher use of instructional materials, (b) teacher's instructional activities, (c) classroom management, (d) set induction, (e) content focus above the skill/knowledge level, (f) teacher questioning, (g) emphasis on higher-level thinking in the classroom, (h) classroom environment, (i) teacher implementation of calculators, and (j) student activities involving calculators. For each of the 43 classroom instruction and environment indicators and 17 calculator indicators, mean scores for each teacher were computed. From those scores, mean scores for experienced and novice groups were computed for each scale. T-tests were used to compare the two groups of teachers.

Results

Table 1 reports the mean percents, standard deviations, and t-values for the comparison between novice and experienced groups of teachers' behaviors on the ten scales. The experienced teachers scored higher than the novices on each scale. Significant differences were found for four of the eight general classroom instruction scales: use of appropriate instructional materials, set induction, content focus above skill/knowledge and application level, and classroom environment. Two additional scales approached significance: questioning strategies ($p < 0.06$) and emphasis on higher order thinking ($p < 0.07$). Significant differences were not found for either of the two scales which focused on calculator instruction and use. Differences between the groups on teacher instruction with calculators did approach significance at the 0.051 level.

The large standard deviations within groups for several of the scales listed below should be noted. Those scales which elicited a wide range of observations within each of the two groups are as follows: (a) Classroom Management (novices), (b) Set Induction (both groups), (c) Questioning (experienced teachers), (d) Emphasis on

Table 1
Comparison of novice and experienced groups of middle school mathematics teachers' classroom instruction

	Novice Teachers n=14		Experienced Teachers n=14		
Scale	M	SD	M	SD	t
Instructional Materials	25.6	8.1	35.4	9.7	2.92*
Instructional Activities	47.1	7.7	50.6	6.4	1.32
Classroom Management	57.9	10.2	63.2	6.4	1.63
Set Induction	40.8	12.0	51.9	13.2	2.32*
Content Focus Above Skill/Knowledge Level	2.2	2.3	6.0	5.1	2.53*
Questioning	21.9	6.9	29.2	12.3	1.94
Emphasis on Higher Order Thinking	15.8	5.9	22.1	10.9	1.90
Classroom Environment	53.5	15.9	66.9	11.8	2.53*
Teacher Instruction with Technology	12.9	5.4	17.0	5.1	2.05
Student Activities with Technology	10.3	4.5	13.1	4.2	1.69

* $p < 0.05$

Higher-Order Thinking (experienced teachers), and (e) Classroom Environment (both groups).

Discussion

The experienced teachers in this study were found to use instructional materials more appropriately than novice teachers. They were observed using more diversified materials often beyond what the textbook offered, to cover the subject matter in greater depth, and to provide examples based on real-life situations significantly more often than the novice teachers. Experienced teachers also were observed focusing students' attention on the objectives of the lesson, creating an organizational framework for the lesson, stimulating students' interest and involvement, and relating experiences of students to the objectives significantly more than novice teachers. Veteran teachers similarly were found to provide more experiences which involved student analysis, synthesis, evaluation, and problem solving (using both inductive and deductive approaches) than did novice teachers. Finally, students of experienced teachers were observed having more positive attitudes toward learning and being more motivated and interested in class activities.

Four of the eight instructional scales were found not to be significantly different between the two groups. The Teacher Instruction Activities Scale showed overall that novice and experienced teachers were not particularly different in the manner in which they selected, adjusted, and organized instructional information, nor in the way they provided guided and/or independent practice for students. Another area in which no significant differences between groups were found was in classroom management. The Classroom Management Scale examined teacher organization of classroom time, communication of classroom procedures and rules, and structuring and monitoring of student time-on-task. The large standard deviation for the novice group on this scale indicates great variance among its members on some of the indicators. This variance indicates large differences in classroom management techniques among the novices which could have skewed the mean score for that group thus possibly nullifying differences between the two groups.

The other two instructional scales which revealed no significant differences between the two groups were Teacher Questioning and Emphasis on Higher-Level Thinking. Large standard deviations for the experienced teacher group were found on these two scales. The large variances indicate extreme differences in both the use of questioning and emphasis on higher order thinking among the veteran teachers.

The results of this study indicate that although there are several significant differences between experienced and novice teachers, differences were not found in the two scales which specifically dealt with technology. The Teacher Instruction with Technology Scale included instructional indicators for teacher emphasis on estimation and reasonableness of answer, the time-saving feature of calculators, use of calculators as problem-solving tools, and relationship between calculator and paper-and-pencil algorithms. In addition, the scale identifies teacher and student initiation and/or demonstration of calculator use. Student use of calculators for computating, exploring, solving routine and non-routine word problems, verifying answers, and playing games that develop or review mathematical concepts are the indicators for the Types of Calculators Activities Scale.

On average, teacher instruction with technology was low (17% of the time for experienced teachers, 13% of the time for novice teachers), as were student activities which involved technology (13% of the time in classrooms of experienced teachers, 10% of the time in classrooms of novices). This suggests that although a teacher may be experienced in many other areas, this expertise may not necessarily apply to the implementation of calculators.

In addition, the indicators used for the two calculator scales do not address quality of instruction and use. Additional indicators need to be developed which would form a more complete picture of actual classroom implementation. A richer description of the differences between these two groups might also be obtained using in-depth ethnographic methods. Qualitative information obtained from such a study combined with the quantitative results reported in this study would broaden understanding of calculator implementation in schools.

Acknowledgements

Support for this research was provided in part by a grant from the U. S. Department of Education, Dwight D. Eisenhower Mathematics and Science Education Program, award number R168D00311. Opinions and views expressed in this paper do not necessarily reflect those of the granting agency.

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Technology in teacher education: A Florida study

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Introduction

It has been evident for some time that our educational system lags far behind other areas of our society in exploiting the power of technology (Bracey, 1990; Perelman, 1989). A major stumbling block to integrating technology into educational methods has been the availability and quality of training for teachers. There are indications that this lack of attention to technology begins in preservice programs where skills in using technology in teaching are often neither part of the college curriculum nor demonstrated by the teacher education faculty themselves. As a result, teachers "teach as they were taught," and many schools continue to emphasize the same instructional strategy (lecture) and technique (chalkboard) as schools of the 1920s.

The Office of Technology Assessment recently published a report that investigated several aspects of technology integration in education (U. S. Congress, 1988). The study revealed that only 18 states (36%) required a computer-related course in the teacher education program. Seven states (including Florida) recommended that a technology course be provided for education majors, and the remaining 25 states had no state requirement or recommendation. Another survey showed that only eight states included a requirement for computer literacy for initial teacher certification (Singletary, 1987). While the majority of teacher education programs have apparently not required technology courses, there are indications that most are attempting to address technology skills, albeit with varying success (Carr, Novak, & Berger, 1992; Mathison, 1986; Fratinni, Decker, & Korver-Baum, 1989). The current study was conducted to add to the information base on what skills are being taught and the problems faculty encounter in teaching them.

Methods

The study was designed to gather information on how Colleges of Education in Florida are addressing the task of teaching technology skills to future teachers and to examine issues impacting further integration at these sites. Using a prepared survey instrument, the authors interviewed key personnel on site at each of the nine Florida public university Colleges of Education. Follow-up information was gathered by telephone. Both faculty who teach technology courses and those who teach content/methods courses were interviewed. Each of the following questions was addressed in a separate part of the questionnaire and was answered by tenured or tenure-earning faculty members:

1. How much are technology-based skills being addressed in each content area?
2. Do students and faculty currently perceive they have adequate access to necessary technology resources?

3. What do faculty members perceive to be the greatest obstacles to their use of technology in teaching teacher education courses?

Part I: Technology-based Skills in Major Content Areas

At each of the nine universities, faculty who are currently teaching content/methods courses were interviewed in their respective areas of expertise. For each content area, a series of skills utilizing technology specific to the content was listed. The respondents were asked to indicate whether or not they felt the skills are necessary for teachers, whether or not they are taught and, if so, in which course they are taught. Each content area was sampled by asking only one faculty member to respond for each university, regardless of the size of the program or the number of faculty teaching in the content area.

Part II: Technology Resources

The issue of technology resources was analyzed from both student and faculty perspectives. A technology "expert" at each university was asked to complete this section of the questionnaire and to provide information on the availability and usage of resources. In the student area, a 13-item survey was used to gather information on student access to hardware and software (e. g., CD-ROM, videodiscs, modems, and printers). The faculty resource portion of the survey gathered information on the availability and usage of technology for teaching and research. This 20-item part of survey was designed to provide a framework of faculty access to hardware, software, and other resources.

Part III: Problems and Issues

In this section, all of the faculty members previously interviewed (including the various content areas and technology experts) were asked to rate the factors impacting the integration of technology in their College of Education. A 5-item Likert scale was used to measure their responses, with alternatives ranging from Very Serious Problem (1) to Very Satisfactory Situation (5). Respondents were also asked for additional comments on factors impeding use of technology and solutions to address these problems.

Results

Answers to the survey questions varied considerably across programs at the nine public universities surveyed. It was also determined that the situation with regard to how technology needs are addressed in the programs is in a state of flux. The initial finding was that only four of the nine programs require a technology skills course, and two others have no such course even as an elective. However, some programs that have had no such course are planning to add one, while others have recently eliminated their course. In addition, some programs anticipate the arrival of new technology resources within the next two years while others predict having to make do with current resources for some time to come. It was also found that the extent to which technology skills were addressed in specific content areas was related to the varying interests and skills of specific faculty members. Even within the same program, two different faculty members teaching the same course may or may not address the same technology-related skills or may address them to a different extent (e. g, discussion vs. hands-on use). Since the situations with regard to technology integration could

Table 1
Technology Application Skills Addressed in Programs

Area Name and Number of Skills in Area	Mean % of Skills Taught	Mean % of Skills Not Taught	Range (Across all Programs)
General use skills (11)	65.4	30.1	23.5—94.1%
Science (7)	55.6	44.4	14.3—85.7%
Mathematics (6)	63.0	31.5	16.7—83.3%
English (4)	22.2	69.4	0—75%
Social sciences (5)	48.9	51.1	0—100%
Elementary education (7)	39.7	54.0	0—85.7%

Note. Skills taught and not taught may not total to 100% because skills that were not taught because they were considered unimportant in the program were not included.

change rapidly, faculty were asked to report data to reflect the current status of programs. Data should be viewed as a "snap-shot" of preservice programs at the time of the survey. Results on each of the three specific issues of interest are reported below.

Issue 1: Technology Skills Taught in Education Methods Courses

Findings on technology skills addressed in six major areas are shown in Table 1. As the ranges for each area indicate, results varied substantially across programs. For example, in social sciences education courses, some programs were teaching none of the technology-related skills identified as important and others were teaching all of them. While programs overall seemed to be addressing about 71% of general-purpose technology skills and 63% of mathematics skills, the majority of technology-related skills that faculty perceived as important for English, social sciences, and elementary education curricula were not being addressed.

Issue 2: Access to Technology Resources

In general, the majority of respondents expressed dissatisfaction with the amount of technology resources available to them for use in preservice courses. As Tables 2 and 3 indicate, they felt they could use more resources for both students and faculty. Overall, only 23.1% of all student resources and 17.8% of faculty resources over programs were considered adequate. For student use, the most-needed item seemed to be open access computers and other equipment such as modems, scanners, and videodisc players. However, all items with the exception of CD-ROM workstations in the library were rated as critical needs. Faculty needs seemed uniformly great for all resources.

When respondents reported that a given resource was inadequate, they were also asked whether or not they had any of the resource at all. When viewed from this perspective, student access to software and faculty access to videodiscs, technology-delivered courses, and to instructional design assistance (e. g., on how to integrate technology into their courses) seemed to be areas of critical shortage. The general finding of dissatisfaction with resources also seemed confirmed by data reported in the section below on obstacles to technology integration.

Issue 3: Faculty Perceptions of Obstacles to the Integration of Technology

When faculty were asked about factors that inhibit their addressing and using technology-related skills, they indicated overall that the greatest problems were time to prepare for incorporating new content into their courses and availability of equipment for use by students. Responses to the item on recognition by faculty that they should be using technology indicated that this is generally not a significant problem.

Table 2
Student Access to Technology Resources

	Programs with None of Named Resource		Programs with Inadequate Amount of Resource		Programs with Adequate Amount of Resource	
	Number	%	Number	%	Number	%
1. Open access computers	1	11.1%	8	100.0%	0	0.0%
2. Lab assistant	0	0.0%	7	77.8%	2	22.2%
3. CD-ROM workstations: COE	1	11.1%	6	77.8%	2	22.2%
4. CD-ROM workstations: library	1	11.1%	3	44.4%	5	55.6%
5. Modems	3	33.3%	5	88.9%	1	11.1%
6. Scanners	3	33.3%	5	88.9%	1	11.1%
7. Laser printers	4	44.4%	4	88.8%	1	11.1%
8. Videodisc players	0	0.0%	8	88.9%	1	11.1%
9. Software preview library	2	22.2%	4	66.6%	3	33.3%
10. Titles for checkout	5	55.6%	3	88.9%	1	11.1%
11. Access: University mainframe	3	33.3%	3	66.6%	3	33.3%
12. Printing: Mainframe	4	44.4%	2	66.6%	3	33.3%
13. Consumables	0	0.0%	5	55.6%	4	44.4%
Average % over all resources		**23.1%**		**76.9%**		**23.1%**

Table 3
Faculty Access to Technology Resources

	Programs with None of Named Resource		Programs with Inadequate Amount of Resource		Programs with Adequate Amount of Resource	
	Number	**%**	**Number**	**%**	**Number**	**%**
1. Classrooms w/computer setup	2	22.2%	4	66.6%	3	33.3%
2. Classrooms w/projection unit	2	22.2%	6	88.9%	1	11.1%
3. Computers on carts	1	11.1%	6	77.8%	2	22.2%
4. Computer for each fac. member	1	11.1%	6	77.8%	2	22.2%
5. LCD projection units	0	0.0%	6	66.7%	2	33.3%
6. Video projection units	1	11.1%	5	66.7%	3	33.3%
7. Videodisc players available	1	11.1%	5	66.7%	3	33.3%
8. CD-ROM players: Research	1	11.1%	7	88.9%	1	11.1%
9. Scanners: Faculty development	3	33.3%	6	100.0%	0	0.0%
10. Support staff	4	44.4%	3	77.7%	2	22.2%
11. Courses delivered by computer	5	55.6%	3	88.9%	1	11.1%
12. Courses: Distance ed.	6	66.7%	2	88.9%	1	11.1%
13. Faculty-made videodiscs	5	55.6%	3	88.9%	1	11.1%
14. Faculty-made CAI/multimedia	4	44.4%	4	88.9%	1	11.1%
15. Tech. workshops for faculty	2	22.2%	6	88.9%	1	11.1%
16. Staff-maintain comp. resources	1	11.1%	6	77.8%	2	22.2%
17. Staff-Provide faculty inservice	3	33.3%	4	77.8%	2	22.2%
18. Staff-ID support	5	55.6%	4	100.0%	0	0.0%
19. E-mail accounts	2	22.2%	5	77.8%	2	22.2%
20. DIALOG accounts	5	55.6%	3	88.9%	1	11.1%
Average % over all resources		**30.0%**		**82.2%**		**17.8%**

Table 4
Faculty Perceptions of Problems and Issues Related to Integrating Technology into Teacher Education
(N=57)

	Unsatisfactory		Satisfactory	
	#	**%**	**#**	**%**
1. Availability of equipment for student use	35	63.6	18	32.7
2. Availability of equipment for faculty use	27	49.9	22	40.0
3. Availability of materials for student use	30	57.7	17	32.7
4. Availability of materials for faculty use	29	53.7	22	38.5
5. Availability of qualified faculty to teach	25	45.5	24	43.6
6. Availability of lab/support personnel	26	47.3	23	41.8
7. Availability of training for faculty	26	49.1	21	39.6
8. Motivation among faculty to use technology	24	44.4	21	38.9
9. Time to incorporate new skills and resources	40	74.1	8	14.8
10. Recognition by faculty that technology is a necessary area to include	20	37.0	26	48.2

Note. Ratings and N's may not total to 100% because some respondents did not answer items or were uncertain of answers.

Motivation among faculty to use technology and availability of qualified faculty and staff were also perceived as lesser problems, but even these findings varied considerably from program to program.

Discussion and Recommendations

In the view of faculty who participated in the survey, the lack of attention to technology-related skills was related to problems with available resources and time to integrate them into curricula. Most faculty seemed to be aware that they should be addressing technology in their teacher preparation courses but felt unable to do so because available time and resources made it unrealistic.

Equipment needs

Nearly all of the personnel who were using technology heavily emphasized that their equipment and software were often out-of-date and/or in need of repair. None of the programs seemed to have a dependable technology budget. Many of the hardware and software resources used in the programs were obtained by individual faculty members from grant funds.

Preparation time

Although most faculty members were making attempts to address technology skills pertinent to their content area, they indicated they were frustrated by the lack of time available for the formidable task of implementing technology into their courses. Since few of the programs had staff assigned to assist them in this task, most faculty member were responsible for keeping abreast of trends in the content area, researching new hardware and software, obtaining these resources (frequently by writing proposals and obtaining grants), learning to use the new materials, and devising teaching strategies and materials to share with students in teacher education methods courses.

Comparison with School Districts

Some faculty members pointed out that the large school districts near them provided both fulltime staff dedicated to inservice training and release time for their teachers to be trained in technology skills. They also had a yearly technology budget with which they could update their resources. In these locations, school districts clearly outdistanced teacher education programs in their ability to provide adequate technology training.

Required Technology Skills

Faculty seemed to agree that certain technology skills (e. g., word processing, computer gradebooks) were probably essential for all teacher education majors, while many others (e. g., selecting and using software types, using videodiscs and telecommunications) should be learned as prerequisites for skills studen ts would later address in each of several content area methods courses. While there was no clear agreement on whether or not a basic technology course should be mandatory for teacher education majors, everyone seemed to feel that these skills needed to be learned before students take methods courses. However, coverage of these skills was inconsistent both within and among programs.

Summary and Recommendations

Data from the survey and comments from faculty who participated in it were used to develop the following recommendations:

1. Make resources available—The rate at which technology changes makes it essential that all teacher education programs have a consistent plan for providing, maintaining, and upgrading their technology resources. Yearly funding plans should be developed by faculty in conjunction with administration to assure that each program can update resources and keep current with new instructional developments in the field. Most importantly, teacher education faculty should not be expected to supply their own hardware and software through grants. This practice makes faculty less able to focus on their main concern of preparing technology-based materials and strategies for use in their courses.
2. Give faculty support—Faculty expect to spend a portion of their professional time updating their skills and preparing new teaching materials. But preparation that involves technology presents unique and time-consuming problems. Administrators of teacher preparation programs should recognize and support faculty efforts to keep current in this area by providing whatever kinds of support are most needed in the program. These include release time, staff support, and sponsored workshops.
3. Require technology skills—All teachers should leave their preservice programs knowing they have a fundamental base of technology skills. Whether this is achieved through a required technology course or within content methods courses or even if students are to learn them on their own, all teacher education majors should be asked to demonstrate technology competency specific to their major before they graduate.

Finally, further studies are needed to identify how faculty can best be supported in their efforts to integrate technology into preservice programs. In light of the wide variation between programs, it may be that strategies should vary according to program characteristics. Further studies may also focus on whether or not elementary and secondary programs differ in the extent to which technology is being addressed.

Conclusion

Although this study may supply more detailed data on Florida preservice programs than are currently documented elsewhere, it is felt that the problems identified here are not unique to Florida. On the contrary, the situation in Florida may be considerably better than in other locations because of the state's high-profile commitment to technology in education and its being one of the few states that recommend a technology course be provided. National studies indicate that the lack of attention to technology requirements in preservice programs is widespread.

University programs are, by definition, expected to be models and training sites for the latest in teaching methods and materials. But until more emphasis is placed on giving faculty what they need to address technology skills adequately, teacher education programs may find themselves lagging behind the very school districts for which they are supposed to supply trained teachers. This study supplies tentative evidence that the majority of Florida teacher educators are well aware of the important role technology can and should play in improving education and are struggling to play their part in preparing teachers who will recognize it as well.

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School restructuring through an educational technology initiative: One state's experience

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Introduction

The introduction of technology into the public schools is viewed as an important tool for restructuring schools and improving teaching and learning (Newman, 1992; Stoddart & Niederhauser, 1993). In states across the country millions of dollars of public money have been invested in an effort to computerize instruction (The Office of Technology Assessment, 1988). It has been estimated that, within the next five years, microcomputers will be routinely used in most classrooms over a wide range of the curriculum (Newman, 1990).

Educators have high expectations for instructional technology. Many policy makers and educators believe that technology can revolutionize traditional teacher-directed approaches to instruction (Collins & Brown, 1990; Collins, Brown & Newman, 1990; diSessa, 1986; Dwyer, 1980). They argue that by using microcomputers, teachers can more effectively individualize instruction and make teaching and learning student-centered. "Computers in education are revolutionary because they make possible great teaching in a system dedicated to mass education...by supporting person-to-person educational influence, not by replacing it" (Dwyer, 1980, p. 113).

The role played by instructional technology in the school change process, however, is the subject of debate (Newman, 1992). While some educators envision schools transformed by technology others argue that little will change--existing practice will shape and coopt technology use (Cohen, 1988; Cuban, 1986). Indeed, the educational software programs which dominate the U.S. market are based on an instructional philosophy that fits well with traditional approaches to instruction and student assessment (Bailey, 1992; Stoddart & Niederhauser, 1993). This paper explores the potential of investment in technology as a means to restructure educational practice by analyzing the educational outcomes of one state's investment in an educational technology initiative.

The Utah Educational Technology Initiative

Over the past three years the State of Utah has made a substantial investment in educational technology. Between 1990 and 1992, the state legislature through the Utah Educational Technology Initiative (ETI) has made approximately 42.8 million dollars available to Utah school districts and colleges of education for the purchase of educational technology and the training of teachers to use this technology. In addition, school districts and colleges of education have matched this funding with one dollar of their own finds with every three dollars they have received from the ETI. Utah businesses and technology vendors have also contributed to the Utah Educational Technology Initiative by selling hardware and services at discounts or by providing staff training. As Table One shows over 100 million dollars have been devoted to educational technology in Utah in the past three years.

Table 1
Funding of the Educational Technology Initiative (1990-1992)

Allocation from the state legislature	$42,800,000
Vendor discounts and training services	$21,800,000
Support from business and industry	$5,700,000
District and college matching funds	$26,300,000
Grants from technology and other companies	$11,100,000
Total	**$107,000,000**

This represents an investment of about $35,000,000 per year or about 3% of the regular school expenditure. In the 1990-91 school year this was twice as much as was spent on Chapter I programs ($17,073, 891), about 8 times as much as was spent on textbooks and lab fees ($4,088,802) and 9 times as much was spent on reducing class size ($4,000,000).

This massive investment of resources in the ETI demonstrates Utah policy makers' belief that educational technology has the potential to increase student achievement, improve school functioning, influence curriculum change, and contribute to teachers' professional growth.

Method

The findings presented in this paper are drawn from data collected as part of an evaluation of the Utah Educational Technology Initiative by the Beryl Buck Institute for Education. The evaluation is built around the central concept of portfolio analysis, an evaluation method that incorporates the collection of both quantitative and qualitative data at different levels of analysis and uses a number of sources of evidence to gauge accomplishments. In the analyses reported in this paper we draw on three levels of data: (1) district level data--analysis of district ETI proposals and qualitative case studies of four school districts that include interviews with district ETI coordinators, administrators and teachers and observations of school ETI projects; (2) school level data which utilizes principal and teacher surveys; and (3) student level data which focuses on standardized test scores.

District data

In order to receive ETI finding each of Utah's 40 school districts was required to submit a written ETI proposal to the State ETI Committee. Funding was contingent on committee approval. These proposals were analyzed to categorize the district's technology goals and evaluation criteria as a measure of technology focus.

The evaluators also conducted case studies of four school district--two urban and two rural districts--to provide an indepth view of the implementation process. A researcher visited each district for three days and interviewed district administrators and teachers about the development and implementation of the district's Educational Technology Initiative plan. The researcher reviewed documents and visited 3 to 4 schools to observe the plan in operation. All interviews were tape recorded and transcribed.

School Data

In the fall of 1991 surveys were distributed to principals and teachers in all schools receiving ETI funding--387 elementary schools and 197 secondary schools. The principal survey asked about the technology equipment purchased, its' location and use. Surveys were returned by 393 principal (276 elementary, 62 junior high school middle school and 55 high school)--a return rate of 70%. The teacher surveys focused on the amount and type ofinstructional technology use. Principals were asked to distribute surveys to a grade-level stratified sample of teachers who were actively involved in the school's ETI project. Surveys were returned by 960 elementary school teachers (313 K-2 teachers, 329 3-4 teachers and 318 5-8 teachers and 523 secondary teachers (163 6-8 teachers, 204 9-10 teachers, and 156 11-12 teachers. The overall response rate was 78% or about 2.6 teachers per school. The sample of teachers within schools is biased towards more active technology users. In light of this, inferences should not be made from these data concerning the extent of computer use by teachers in general.

Student Achievement Data

To evaluate the impact of the ETI on student achievement we compared student scores on the Stanford Achievement Test (SAT) in two groups of schools: an ETI treatment group and a control group. The ETI treatment group schools met the following criteria: (1) their ETI project was fully operational no later than January 1991, and had functioned without problem from at least January to June 1991; (2) the projects focused on grade 5, 8 or 11-the grade levels assessed by the Utah Statewide Testing Program; and the ETI project concentrated on mathematics and reading--two subject areas assessed by the Utah Statewide Testing Program. Forty-three elementary schools, 11 junior high or middle schools and 10 high schools met the criteria. Given the relatively small number of secondary schools in the ETI treatment group we omitted them from further analysis, and focused on the 43 elementary schools. The 409 elementary who did not meet the treatment group criteria were used as the "control group".

The Utah Statewide Testing Program requires that the Stanford Achievement Test be given to all Utah students enrolled in grades 5, 8 and 11. School scores are based on the median student score for a grade level. To account for the impact of student family background characteristics the Statewide testing program calculates an expected score based on the socio-economic status of the school's student population. The school's actual score is compared to the expected score to assess whether students in a school are performing better or worse than would be expected. To analyze the effects of the ETI on student achievement change between 1990 and 1991 in 5th grade mathematics and reading SAT scores for the ETI treatment sample were compared to the control group.

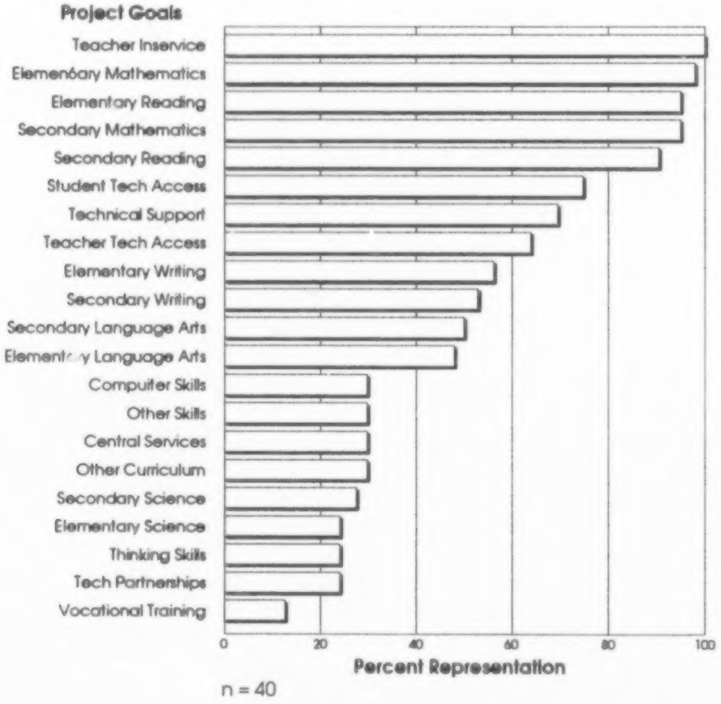
Findings

The findings are reported at three levels: (1) the district; (2) the school; and (3) the student. In the analysis of the data collected at the district level we discuss district ETI goals and the implementation process in the four case study districts. The school level data is drawn from the principal and teacher surveys and focuses on the utilization of instructional technology at the school site. The student level data analyzes the achievement of fifth grade students in mathematics and reading in a group of ETI schools and control schools and the instructional programs in place in those schools.

District Level Data

The implementation of the Utah ETI was driven by the plans laid out in the district proposals. The State ETI committee reviewed and approved proposals but did not provide project guidelines. District, proposals, therefore, varied widely. At one end of the spectrum were districts who embraced a 'site-based management philosophy' and allowed individual school faculties to develop their own projects at the other were districts where the administration selected the hardware and software to be used in all the schools in the district. Despite these differences in structure, however, a common pattern was observed in the district proposals. The majority of district proposals focused on improving student achievement in mathematics and reading and indicated that project success would be evaluated on the basis of improvement in students' standardized test scores.

ETI Proposals. The project goals and evaluation criteria included in the ETI proposals of Utah's 40 school districts were analyzed. As Figure 1 shows inservice



teacher training was a priority for all districts. Over 85% of district proposals also focused on improving student achievement in mathematics and reading. Almost two thirds of the districts listed increasing student and teacher access to computers as a goal, and 70% indicated they would provide necessary technical support. In contrast, goals such as vocational training, developing partnerships, improving thinking skills, and elementary science were mentioned in a minority of proposals.

Thirty-eight out of 40 school districts (95%) planned to evaluate their ETI projects by increases in student achievement scores in reading on standardized tests such as the Standard Achievement Test (SAT) and the American College Test (ACT). These districts also specified improvement criteria such as "an increase in percentile points by 2% a year" and "80% of students will attain the 60th percentile on the SAT by 1992". One hundred percent of districts planned to evaluate their ETI projects on the basis of improved student achievement in mathematics.

Case Studies. The case studies conducted in two rural and two urban school districts focused on implementation of the ETI process. In all four cases computer vendors were extremely influential in: (1) the selection and installation of software and hardware, and (2) the training of teachers to use instructional technology.

The developers of the ETI required all school districts to develop and submit for approval an educational technology plan. The four districts studied established ETI committees made up of school administrators, teachers and parent representatives to write the plan. These individuals typically were interested in educational technology but lacked expertise in the area. All four district ETI committees turned to local computer vendors for advice on what computer systems and software to purchase. Typically, experts from a variety of companies were invited to demonstrate their systems. One large urban school district held a "Vision Conference" in which representatives from six leading national and local companies (Apple, AT&T, IBM, Novell, Tandy and Wasatch Educational Systems) were invited to present "their vision of technology and how that might fit into the schools". The Vision Conference was followed by a series of meetings at which individual school plans were selected. In this district the principal and teachers in each school selected the hardware and software systems--resulting in a great deal of diversity across the district. In the three other districts, a unified hardware system and software programs were selected for all the schools in the district by the ETI committee. In all four districts, however, the selecting of the educational technology program was made by individuals with limited expertise in instructional technology. These individuals were strongly influenced by the software vendors. Most districts opted for an Integrated Learning System (ILS) package which includes the hardware, software, teacher manuals, student workbooks, and pre- and post- assessment options.

Computer vendors were also influential in the training of teachers. Under the terms of the ETI districts were not allowed to use ETI funds for staff development. Most of the computer companies included in their package 3 to 5 days of training for teachers. This training typically consisted of basic computer operation and an introduction to one or two software programs. In many cases this was the only training the teachers received. The teacher survey data indicates that 34% of the teachers actively involved in the Utah ETI received less than ten hours training in the use of instructional technology. Forty-five percent report they received no training at all. Personnel in all four districts noted that teachers' lack of expertise in technology was a major impediment to the implementation of the ETI. Although all 40 school districts had given teacher training the highest priority in their ETI proposals few had been able to implement it in practice.

School Level Data

Types and Amount of Technology Use. The data on technology utilization are drawn from surveys of 393 principals and 1403 teachers. Microcomputers in labs or classroom settings are the most frequently used type of technology inboth elementary and secondary schools. Fewer than 20% of teachers report having access to laserdiscs, scanners, or modems. In the 3 year period from 1989-92, the number of instructional computers in elementary schools more than doubled from 5,308 to 10,786. In secondary schools the number increased from 7,345 to 10,855. Overall, the number of computers in classrooms increased 83% from 3,218 to 5,893 and the number of computers found in computer labs increased 79% from 8,161 to 14,569. Significantly more elementary school teachers (81%) use computers in lab settings than secondary school teachers (67%). The average student to computer ratio in elementary schools declined from 20 to 1 to 11 to 1 and in high schools the average computer to student ratio declined from 10 to I to 6 to 1.

In the same time period, Utah public school teachers report that they doubled the amount of time they spent using technology for instructional purposes. Elementary teachers increased from an average of 1.26 hours per week to an average of 2.99 hours per week and secondary school teachers increased their average use from 3.4 hours to 7.8 hours per week. The increase in hours of computer-assisted instruction is significantly greater in secondary schools (4.4 hours per week) than in elementary schools (1.7 hours per week). In the 1991-92 school year the average elementary student spent approximately 60 minutes a week using a computer and the average secondary student 135 minutes a week.

The number of computers available to elementary and secondary teachers, however, is about the same--10,855 computers in secondary schools and 10,768 computers in elementary schools. Secondary teachers, therefore, are making a greater use of the available computers than elementary school teachers. This may be a function of their greater experience with computer-assisted instruction. In 1989, before ETI, secondary teachers had more computers available to them and used them more frequently than elementary school teachers.

Instructional Use. Elementary teachers use computers most frequently for mathematics instruction (74%) followed by reading instruction (49%) and writing instruction (42%). The predominant instructional purposes are those of teaching the Utah Core Curriculum, playing games and word processing (see Table 2). The majority of elementary teachers use computers to instill basic skills through drill and practice (82%), for enrichment (74%) or for review or remediation (70%). Fewer use computers to develop higher order thinking skills (60%), enhance creativity (60%) or present new concepts (44%).

As Table 2 shows, secondary school teachers actively involved in the ETI use computers most frequently for writing instruction (53%) followed by mathematics instruction (38%) and reading instruction (20%). The predominant instructional purposes at the secondary level are word processing (82%), grading student work (78%) and teaching the Utah Core Curriculum (64%). Less than 40% of respondents reported using computers in simulations, as a reward for students, for games, or for visual presentations. Only about one secondary computer user in seven uses the technology for telecommunications or to access remote data bases. Secondary school teachers also use computers extensively for drill and practice (60%), enrichment (64%) and review and remediation (55%). They use computers more frequently, however, to enhance students' creativity (68%), stimulate higher order thinking (64%) and introduce new concepts (59%).

Secondary school teachers not only use computers more frequently but also use them in more elaborated ways than elementary school teachers. There are significant differences in use in every category of instructional purpose (see Table 2). To examine differences between elementary and secondary teacher reports of their instructional use of technology, a 1 x 2 Kruskal-Wallis nonparametric Analysis of Variance was performed for each category. Significant *p* values are reported in the table. Elementary teachers are more likely to use the computer

Table 2
Percentage of Actively Involved ETI Teachers Using Technology for Different Instructional Purposes and Goals

	Level		
InstructionalPurpose	**Elementary**	**Secondary**	
Teach Core Curriculum	73.3	64.6	**
Games	68.5	40.5	***
Word Processing	66.5	82.0	***
Grading/Record Keeping	57.1	75.9	***
As a Reward	47.8	37.6	***
Testing	32.9	51.0	***
Simulations	30.9	40.0	**
Visual Presentations	12.9	32.4	***
Telecommunications	11.2	16.3	*
Instructional Goal			
Drill and Practice	82.0	61.0	***
Enrichment	74.2	65.1	***
Review and Remediation	70.2	55.6	***
Higher Order Thinking	60.3	64.1	
Creativity Enhancement	59.5	68.0	**
Concept Introduction	43.8	58.8	***

Note: *** = $p < .001$, ** = $p < .01$, * = $p < .05$

to teach the core curriculum and for computer games significantly more than secondary school teachers. Secondary school teachers, however, show significantly greater use in every other category. As Table 3 shows, elementary school teachers use the computer significantly more than secondary school teachers for traditional instructional purposes--drill and practice, enrichment, review and remediation--and significantly less for conceptual instruction involving creativity enhancement and concept introduction.

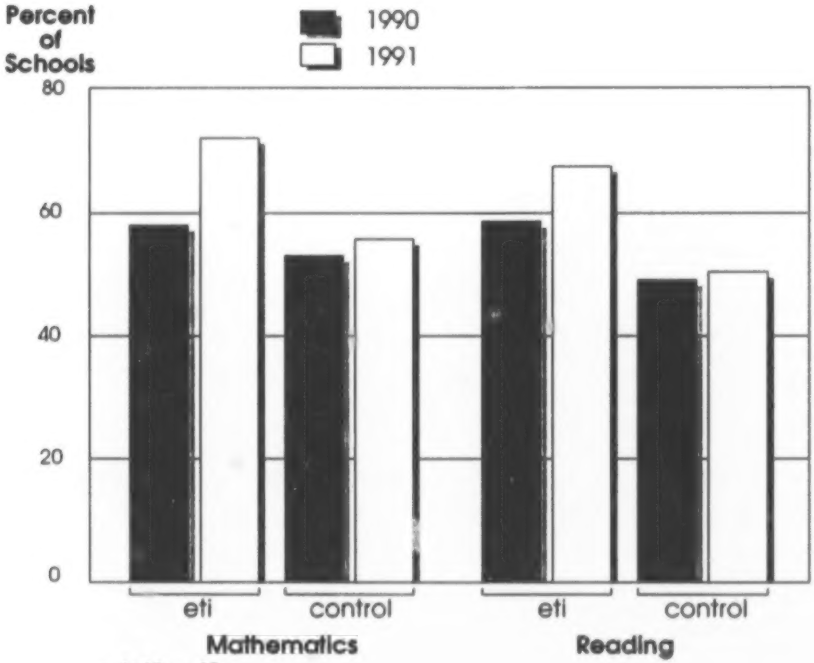
Student Level Data

To analyze the impact of the ETI on student achievement we focused on change in the fifth grade SAT mathematics and reading scores from 1990 to 1991. Figure 2 shows the percentage of ETI treatment and control group schools scoring above their predicted scores in mathematics in 1990 and 1991. As Figure One shows, the percent of the control schools scoring above their predicted math scores remained basically the same from 1990 to 1991. In contrast the percent of the ETI schools scoring above their predicted scores increased from 56% in 1990 to 76% in 1991. A McNemar's chi square forsignificance of change indicated the change in the ETI treatment schools was statistically significant (1 df= 3.267, p = 0.07) but nonsignificant in the control schools (1 df = 0.131, p = 0.72).

A similar trend was apparent in reading achievement (see Figure 2). In 1990, 51% of the control group schools scored above their predicted reading scores, compared with 53% in 1991. Although this represents a slight trend toward improvement, it is of small magnitude. The change in the percent of ETI elementary schools scoring above their predicted reading scores in 1990 and 1991 is considerably greater. In 1990, 56% of the ETI schools scored above their predicted score, compared with 67% in 1991. This change, however, was not statistically significant (McNemar's chi square, 1 df = 2.273, p = 0.13).

Interviews with a random sample of 15 principals of the ETI control group schools indicated that all of these schools had focused on drill and practice in mathematics and reading and the improvement of student tests taking

Project Goals



n (eti) = 43

n (control) = 409

skills. According to the principals computer-assisted instructions was one piece of an instructional package that had focused on raising tests scores. In 14 of the schools students were engaged in an average of 20 minutes of laboratory-based computer assisted instruction utilizing drill and practice programs. In the 15th school, students did drill and practice using paper and pencil work sheets. In all the schools focus on drill and practice was integrated with explicit instruction on test taking skills and teaching to the test.

Discussion

The first phase of the ETI is meeting many of the state's basic goals for technology. Utah elementary and secondary students now have more access to computers and spend more time using them. Teachers and administrators believe the use of technology in schools is improving student learning and preliminary findings support this view. The results of state performance tests indicate that computer assisted instruction has significantly improved the mathematics and reading scores of low achieving students in ETI schools where computer-assisted instruction has been in place for at least one semester. Technology, however, is primarily used for traditional instruction. Elementary school teachers use computers most frequently for drill and practice in mathematics and reading. Secondary school teachers tend to focus on computer-assisted writing projects. Few teachers or students use computers to access communications networks or databases or use computers as tools for problem solving.

The findings reported in this paper do not support the view that the Utah ETI is changing teachers' instructional practice. Rather, teachers are using computers to fit in with their existing approach to teaching. At the district, school and classroom level the primary purpose of computer assisted instruction is to instill basic skills through drill and practice. The restricted use of computer-assisted instruction is not confined to Utah. Becker (1992a; 1992b), in discussing the findings of national and international surveys on computer, reports that computers are typically used to support traditional practice. In traditional practice computers are used as, "substitutes for paper-and-pencil worksheets and for "enrichment" to reward the completion of other work. Except for secondary school English teachers, the major use of computers was to help students master basic facts or skills" (Becker, 1992b, p.4).

This relatively restricted use of technology may be due to the fact that most Utah teachers received minimal training in the instructional uses of technology. Becker (1992b) emphasizes that teacher education is the key to developing more elaborated use of instructional computers: "One of the most consistent findings on the findings of exemplary computer-using teachers is that they work in schools and in districts that have invested heavily in staff development and on-site staff support for computer using teachers" (p 11). InUtah the majority of teachers had received less than ten hours of training in the instructional use of computers.

This lack of expertise in computer-assisted instruction was apparent at all levels of the ETI implementation process. District and school administrators, parents and teachers--all with limited knowledge and experience of educational technology--were asked to make decisions about the purchase of millions of dollars worth of computer hardware and software. It is not surprising that they sought advice from the most available source of expertise--the computer vendors. Currently, the computer software market is dominated by software companies that promote the use of Integrated Learning Systems (ILS) (Bailey, 1992). ILS typically incorporate traditional drill and practice approaches to teaching and learning (Stoddart & Niederhauser, 1993). The instructional goals of these systems fitted well with the goal of districts to improve student test scores in mathematics and reading. To complete the cycle, such programs did significantly improve student standardized tests scores. The tight fit between ILS systems, traditional instruction and standardized tests makes the cycle hard to break.

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Technology development for educators: Three models of implementation

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Review of the Literature

Fewer than one-third of practicing teachers perceive themselves as prepared to teach with computers (U. S. Congress, 1988), and while efforts to improve this situation are underway, success has been largely limited to a few demonstration sites (Schrum, 1991). Research has examined technology use in schools, but has focused on students rather than teachers (Glenn & Carrier, 1989). One possible reason for this may be a lack of technology rich environments in which to determine if teachers are using the skills they have learned.

The literature identifies elements thought to be necessary for technology implementation. Extensive practice, comfortable atmosphere, individualized attention and voluntary participation have been reported as significant (Stecher & Solorzamo, 1987; Sturdivant, 1989; Zammit, 1992). Yet few models exist for a district to study as it begins the process of implementing technology. More important, these reports do not provide the voices of educators.

Purpose

The purpose of this study was to describe three school districts' technology implementation efforts as they evolved, to interview participants and to present their perspectives. Another goal was to gain insight and identify the types of support necessary as teachers learn about technology. The questions with which I began were:

- What characteristics do the participants bring to their respective districts' plans regarding technology? For example, what are their attitudes to technology in general and why did they become involved?
- What specific aspects of these models impact educators' adoption, use and inclusion of technology into the teaching and learning process?
- What other factors appear to influence the implementation process?

Research Methods

I worked simultaneouslywith three school districts as a consultant. As such, I had access to educators and administrators. Although I made suggestions and contributed to the development of these models, each district evolved goals arising from its culture and needs.

I began this research with a qualitative framework; using ethnographic techniques. I formally and informally interviewed educators, participated in meetings, kept journal notes on activities and observed educators in their classrooms over a two-year period.

I analyzed the data from multiple perspectives. The implementation plans were ongoing so I adopted an ecological framework, viewing each district's situation as it evolved. As a participant observer, I had a view of the successes and difficulties. Also, I interviewed participants about their reasons for joining the project as well as ongoing details of their experiences. My personal involvement with technology and teacher education certainly influenced the ways in which I framed questions and interpreted the data.

Discussion of Research Questions

Two of the districts were in small rural communities and one was in an industrial city. Each district identified a unique manner of implementation. These efforts included teacher mini-grants, consultant workshops, development of a "school within a school" and a traveling technology support person.

I will present the research findings from the three districts as individual and unique models, and also look at the three districts as representatives of larger efforts currently taking place. I will begin by reviewing the research questions.

Characteristics of Participants

Looking at who the educators are and why they are involved can inform efforts to encourage the thoughtful use of technology.

What attitudes did these educators hold regarding technology in educational settings? Why were they involved in this innovative activity in their district? The vast majority of individuals came to the projects willingly and did so with a positive and curious attitude about technology. These educators rushed toward opportunities to learn and experiment. Teachers identified themselves as "eager to discover" or "nervous but willing to jump in" and even "I'm terrified, but this is an opportunity too good to miss." One teacher told me joyfully that he had long encouraged his district to take an interest in technology. "Now they are going to begin with the purchase of new equipment and move on from there," he said. "Yes!" I also heard comments similar to this, "Suddenly I have a voice in deciding about technology, and I have to learn more before I can make decisions."

Circumstances forced some participants to become involved. Teachers who wanted to join a Year Round school within a school [District A] found technology was part of the program. One woman explained, "I will not use the darn things [computers]; they can sit in the back of my room but no one can make me use them."

In District C, "assigned" principals comprised one distinct group. About half of these individuals considered computers as inevitable and joined, albeit grudgingly. Others did not touch the machines and assigned their secretaries to take care of the technology.

Expected Outcomes. The volunteers had a variety of expectations for their experiences. Many wanted enhanced professional development. One group of middle school science teachers had won a grant for a Macintosh and laser disk player, but they knew nothing about the computer or making it all work together. They wanted to have time with the consultant and to practice so they could use their new equipment.

Educators expressed an outcome related to communication between the district and themselves. Many teachers viewed a consultant as a conduit to the administration and an entree to technology decisions. I will describe one situation.

One school had an Apple IIe lab with an odd collection of software. Teachers were not familiar with the software, were unsure what to do in the lab, and as a result, took the students to the lab once a week to play games. Rarely was a connection made between the work in the lab and the curricula of the classroom.

A shared goal emerged from my interviews with teachers. They wanted to "break up the lab and get the computers in the classrooms." When asked what they would do with a computer, one teacher admitted, "I don't know what I can do, but I would like to try - word processing, keeping grades. I know I am ready to try."

Previous efforts to break up the lab had failed. Now several teachers insisted that they had a chance to be heard. I was told, "The administration has not listened to us before, but now you are here to help get our message to them. It helps to have someone impartial to act as go between."

Specific Variables of the Models

Each aspect of the models had some positive results. District A educators developed a support group for sharing ways to use technology, but also volunteered to tackle other tasks. One teacher decided to take a leadership role by reviewing software at a regional technology center.

District B used a change agent, in the form of a technology consultant returning weekly to each school. Each participant asked questions at his/her own computer, based on personal needs. The district tracked the number of emergency calls and found more than a 50% drop. One woman said, "I will wait a whole week until you come to find the answer to my questions. And you always bring something new that I never considered." Another commented, "I have taken afternoon courses but this is better. Here you are showing me solutions to MY work on MY machine."

District B used a method of mini-grants for distribution of technology money. A shop teacher wanted to make videos for safety lessons. The video teacher wanted funding for new cameras. Together they submitted a district mini grant to pay the video club to make the safety tape. With the money the club bought new equipment.

Factors that Influenced the Process

Attributes that Enhanced the Process. The models shared one feature that positively influenced technology implementation. Communication was enhanced between and among those involved. First, each district hired a consultant to work closely with educators, support staff and others. The consultant facilitated vertical communication between organizational levels of the district. Almost without exception people felt the consultant to be a valuable addition to the process. I heard comments such as: "I can complain to you and you anonymously pass my thoughts to the superintendent." "I like the way we identified the kinds of support we need, and then you wrote them into your report to her [the administrator]."

Next, the models fostered horizontal communication among groups. Primary educators were grouped together for discussions in District B and began joint planning. In District A the "school within a school" teachers became a cohort of support. In District C the secretaries developed a strong relationship as they experienced similar challenges. This enhanced collegiality ultimately helped participants identify and pursue shared goals.

The consultant also facilitated moving educational goals into technology applications. Four primary teachers asked to meet with me. We discussed their use of whole language, collaborative authentic writings and frequently used big books. A colleague and I explained how a computer, overhead projector, data projection panel and printer might be used to create shared writings and produce stories in large font. These teachers decided they wanted to try. They needed a cart, access to the school's data projection panel and one computer from the lab. We arranged a demonstration and practice session and the group left determined to begin immediately.

Factors that Disrupted the Process. Lack of organizational support for change was the greatest obstacle to success. This support concerned access to planning, consultant support, release and study time, and availability of supplies. One district routinely arranged for substitute teachers and paid for participants' lunch during the staff development. This expenditure of money and time demonstrated the district's respect for the teachers. Another district expected the teachers to donate their vacation days for inservice. One teacher told me, "I have to use two personal days to learn about the computers and I will, but I will not forget this later; who do they think I am doing this for?"

Another aspect concerned districts' organizational routines, such as ordering. District A, for example, had new machines and no software. After my first visit I recommended software for review. Only later did I learn that it was not ordered for three months. One teacher told me, "They [the administration] always say they want us to do things, but then red tape and delays make it impossible. Who gets the blame when things aren't done?"

Recommendations and Conclusions

I am convinced that there is no best way to teach educators about technology. Each district made progress and difficulties due to limitations of time and money. It appears, from the stories of those involved, that the following three issues must be considered when implementing a technology plan.

Communication. Lack of vertical and horizontal communication stand out as the major difficulty in technology implementation. Traditional patterns of communication must be assessed and ongoing effort must be made to provide open access to decision making.

Time. Districts have difficulty identifying what needs to be done and who has the responsibility for it. Persky found, "…the notion of training is insufficient to encompass the kind of knowledge and support teachers need"(1990, p. 38). Successful use of technology requires more than learning to use a machine, teachers need new ways of conceptualizing the teaching process. We often speak of allowing children the gift of time for learning, yet educators are seldom granted that same gift.

Consultants. It appears that hiring a consultant aids implementation of technology, with the following caveat. One shot visiting experts produce few lasting effects, so the consultant must become part of the process and be accountable for promises. The administration's commitment to technology can be measured by willingness to expend resources, including those spent on a consultant.

Conclusion. In this study, I investigated techniques for integrating technology in educational settings. Administrators and educators do see the value of enhancing the teaching/learning process with technology. The main constraints continue to be inadequate hardware and software, limited time, and underestimated training and support needs of personnel. These are directly influenced by financial considerations, and overarching everything is a lack of communications.

I recently heard Jonathan Kozol speak on the vast discrepancy between rich and poor school districts. He is frequently asked, "Can money really help? Do you really want us to throw money at the problem?" He told the audience that his answer is always the same, "Hell yes, throw money at the problem, throw buckets of the stuff!" (1992)

I am not suggesting that we throw *just* money at technology implementation, however, we must develop examples of technology rich situations in all schools. Only then will we be able to tell what role technology might play in the teaching/learning process. If we are to inform ourselves, we must have adequate knowledge to base decisions. I would rephrase Kozol's words and say, "Throw time at the problem, tons of time for learning, experimenting and teaching with technology."

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Accessing ICLAS network log data to quantify student computer usage in relation to course performance and attitude change

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Introduction

At an increasing rate, educational institutions are adopting LAN-based systems like the IBM Classroom LAN Administration System (ICLAS) as instructional delivery platforms. The use of such instructional platforms allows comprehensive and detailed information to be generated and analyzed for the study of student interactions with courseware. ICLAS, for example, can note the date and time of logon, application used, date and time of logoff, teacher, and class for every network session of any user. The purposes of this paper are to review literature relating CBI (computer based instruction) time-on-task measures to student performance, to provide detail on the instrumentation used to acquire ICLAS log data, and to present the results of an analysis of student information collected on a large class of upper-level undergraduate education majors.

Collecting Usage Data On Computer-Based Instruction

Many reviewers have concluded that CBI results in substantial savings of student time (e.g., Kulik, 1985; Roblyer, Castine, & King, 1988.) Yet, Jamison, Suppes, and Wells (1974) decried the lack of quantitative data to support reports that CBI saved time and posited that the results demonstrated in the studies that they reviewed were preliminary in nature. They recommendedfurther research to support the assertions of time savings, asserting that the ideal model would relate a vector of output measures to the time pattern of instructional inputs and would not be feasible without an experiment of vast magnitude.

Savings in time-on-task continues to be touted as a major advantage of computer-based education, yet relatively few research designs include any provision for careful measurement of time. Those studies specifically reporting on time either do not mention how the time data was collected (e.g., Corbett & Anderson, 1991) or rely on self-reporting from the subjects (e.g. Lawson, 1987). Kitabchi (1987) used a human monitor who observed the subjects and simply reported that time varied. Duffy, et al. (1987), at the other extreme, used an observer at an IBM-PC with a time-recording program to note each subject's actions. Although this level of precision in data collection is possible when working with small samples, few researchers are able to expend the resources necessary for such exact measurements in larger experiments.

Now, using improved technologies, educators have opportunities to gather and to analyze information acquired in the midst of the learning experience. It is currently possible to make objective measures of time-on-task on an individual basis, surmounting the limitations of earlier studies noted by Jamison and others.

Potentially, every keystroke that a learner makes while completing computer-delivered lessons can be captured and analyzed. This brief review of the literature indicates that educators are just now beginning to explore the potential for investigating the phenomena of computer-based teaching and learning. In the future, as technology becomes even more sophisticated, as computers become more capable learners, and as studies such as this one augment the knowledge base, other, even more sophisticated kinds of information will become available.

Research Questions, Hypotheses, and Variables

The major variable in this experiment was student time spent on-task in the computer lab. Three questions were of particular interest—what was the total lab time for:

1) all course applications?
2) computer-literacy applications?
3) pedagogical computer applications?

Measures of three additional dependent variables were also available on this population. Attitude change was defined as the difference between pre-course and end-of-course means on an attitude instrument developed by Troutman (1991). Course knowledge change was defined as the difference in scores between pre-course and end-of-course administrations of a test of computer knowledge. Course grade was a combined measure of test scores and scores on laboratory activities. This information enabled the study of some additional relationships:

4) Is lab time related to attitude change? Literacy lab time to personal use attitude change? Pedagogy lab hours to school use attitude change?
5) Is lab time related to knowledge change? Literacy lab time to literacy knowledge change? Pedagogy lab hours to pedagogy knowledge change?
6) Is lab time related to course grade?

Population and Sampling

The subjects of this study were undergraduate education majors enrolled during the 1992 summer semester in a required Computers in Education Course in the College of Education at the University of South Florida. This non-traditional course uses a variety of instructional methods, media, and settings. The typical student is a senior, with mean age of about 27. The population is also atypical in that, Tampa, the location of the University, is an urban area. For additional details, see Troutman & White (1991.)

Over 200 students participated in the study. Completion of all pretests and posttests was a course requirement. When using the computer lab, each student was also compelled to enter a unique ID and to use a password to prevent unauthorized access. Students who used computers outside of class to complete course assignments were identified and eliminated from the data sample since comparably accurate time-on-task data could not be acquired for them. Owing to this factor and to other forms of attrition, the final sample size was reduced to 163, of which 140 were female and 23 male.

Collection of *.LOG Data

The development of instrumentation and method was an important aspect of this study. It was important that the procedures used be applicable to a broad range of different courses ... not just computer studies. Since a wide variety of faculty and staff might be using these procedures regularly, the means for collecting data and porting it to other applications also needed to be very turnkey in nature.

In order to generate usage data, ICLAS applications were instructed to log data. Later, the data were compiled with the "Format Log Data for Host" option on the supervisor menu. This created a fixed-field-length ASCII file named CLSLOGUP.LOG containing the sequence of logon records. Table 1 describes theauthors' interpretation, based on examination of the *.LOG file, of the fields in each record.

Table 1
Pascal Record Definition for ICLAS *.LOG Record

```
LOGType = RECORD
 Teacher    : STRING[10]; Class     : STRING[6];
 UserID     : STRING[10]; LogInYr   : STRING[4];
 LogInMo    : STRING[2];  LogInDay  : STRING[2];
 LogInHr    : STRING[2];  LogInMin  : STRING[2];
 LogOutYr   : STRING[4];  LogOutMo  : STRING[2];
 LogOutDay  : STRING[2];  LogOutHr  : STRING[2];
 LogOutMin  : STRING[2];  Other1    : STRING[87];
 AppUsed    : String[35]; Other2    : STRING[120]
END;
```

The fields labeled "Other1" and "Other2" are probably space allocated for usage records of courseware specifically tailored to the ICLAS system.

The ICLAS *.LOG data was a chronological sequence of logon sessions. For example, if a student logged on and used Microsoft Works 11 times on 7 different days during the semester, it caused 11 different entries throughout the *.LOG file. It is possible to compile this data with a sequence of wordprocessor edits and spreadsheet manipulations, but the process is very tedious, error-prone, and time-consuming. For this study, a turn-key utility was developed to perform the process. The resultant product, called NETLOG, allows the user to view the raw *.LOG files, compile the data, and export the data in *.DIF format for spreadsheet importation.

```
TEACHERCLASS   ID     APPLICATION
TEACHER1       CLS1   CPU0   MS Works Version 2

#LOGS  HRS     FIRSTLOG        LASTLOG
19     5.6     6/3/92              6/30/92
```

A typical record from the final spreadsheet file of the actual data collected for this study (the entire file is 1433 records, 266 KB.) Note how multiple logons were compiled into one record. The only data lost were the actual times and dates of the individual logon sessions.

The Attitude Change Instrument

The attitude instrument (Troutman, 1991) used consisted of two measures: the Attitude Toward the Uses of Computers in Schooling (ATSC) and the Attitude Toward Personal Use of Computers (ATPC). The ATSC scale measured attitudes toward the general use of computing in school environments in terms of perceptions of: 1) the potential usefulness of computers for instruction and management, 2) the feasibility of using computers in school environments for instruction and management, 3) how computers mightenhance affective outcomes in schooling, and 4) the dependence of society on computer literate citizenry. The ATPC Scale measured attitudes toward personal use of computers in terms of 1) usefulness, 2) interest, 3) confidence, and 4) stereotyping of computer users. The 51 items on these measures were in a Likert format with responses ranging from 5 (strongly agree) to 1 (strongly disagree). An individual's score was the mean of all responses, with negatively-phrased items transformed before computation. For this study, attitude change was reported as the difference between means on pre-course and end-of-course offerings of the instrument.

The Knowledge Change Instrument

The measure of knowledge change for this study was the difference in pretest and posttest scores on a multiple choice test developed for use in the course. This instrument has been content validated, but its reliability has not yet been formally assessed. The 20-item test had two subscores. Ten of the items related to pedagogical uses of computers. The balance of the items fell in the computer literacy domain and were considered to measure general, non education-specific, knowledge of computers. Overall scores on this test potentially ranged from 0 to 20, with pedagogy subscores ranging from 0 to 10 and literacy subscores ranging from 0 to 10. For this study, change in knowledge was reported as the difference between pretest and posttest scores.

Table 2
Statistics for Major Variables (N=163)

	Mean	Mode	Median	Min	Max	Stddev
GPA	3.265	3.500	3.300	2.300	4.000	0.408
GRADE	90.574	91.500[a]	91.500	72.500	101.00	5.945
HRS	7.347	4.270[a]	7.030	1.180	16.550	2.612
LHRS	3.418	5.000	3.300	0.000	13.290	1.600
PHRS	3.930	3.550[a]	3.670	0.900	8.530	1.517
ΔATT	0.185	0.314	0.196	-1.020	3.039	0.449
PΔATT	0.192	0.263	0.158	-1.368	3.263	0.561
SΔATT	0.182	0.000	0.156	-1.125	2.906	0.449
ΔKNW	5.933	5.000	6.000	-3.000	13.000	3.356
LΔKNW	3.025	2.000[a]	3.000	-3.000	7.000	2.160
PΔKNW	2.908	3.000	3.000	-2.000	7.000	1.862

[a] Smallest of more than one mode

Key:
HRS = Total Lab HoursSΔATT = School Attitude Change
LHRS = Literacy Lab HoursΔKNW = Total Knowledge Change
PHRS = Pedagogy Lab HoursLΔKN = Literacy Knowledge Change
ΔATT = Total Attitude ChangePΔKNW = Pedagogy Knowledge Change
PΔATT = Personal Attitude Change

Results

ICLAS produced a 1.37 MB, 4882 record *.LOG file of all lab activity for the semester. After processing through NETLOG, this data was reduced to a 234 KB *.DIF file. The total processing time from *.LOG file to *.DIF file was less than sixty seconds. After all other experimental information was entered in a spreadsheet, the file was ported to SPSS/PC for further analysis. Statistics for all the major experimental variables are presented in Table 2.

Pearson correlation coefficients were computed for all major variables (see Table 3). In addition to these correlations, T-tests and ANOVA procedures were conducted on the major variables using GENDER and MAJOR/PROGRAM (e.g., Elementary Education), respectively, as categorical independent variables. The only significant finding was that females had significantly higher GPAs than males (t=-2.23, p=.027, 2-Tail, N of 127 females and 18 males owing to missing data.)

Discussion

Amount of Lab Time

The mean total lab time per student, in hours, for all course applications was 7.347 hours. The comparable means for computer literacy applications and pedagogical applications were 3.418 and 3.930, respectively. Although

Table 3
Pearson Correlation Coefficients (N=163[a])

Level of Significance (2-Tailed *p*)

		GPA	GRADE	HRS	LHRS	PHRS
C C	GPA	*	.000	.085	.018	.547
o o	GRADE	.4736	*	.000	.000	.022
r e	HRS	.1434	.2926	*	NA	NA
r f	LHRS	.1969	.3071	NA	*	.000
e f	PHRS	.0504	.1798	NA	.4041	*
l i	ΔATT	.0199	.1597	.1554	.1853	.0722
a c	PΔATT	.0324	.2674	.2361	.2568	.1356
t i	SΔATT	.0080	.0573	.0730	.1053	.0146
i e	ΔKNW	.2307	.2278	.1240	.1329	.0733
o n	LΔKNW	.2628	.2162	.1291	.1294	.0859
n t	PΔKNW	.1059	.1598	.0736	.0895	.0324

Level of Significance (2-Tailed *p*)

		ΔATT	PΔATT	SΔATT	ΔKNW	LΔKNW	PΔKNW
C C	GPA	.812	.699	.924	.005	.001	.205
o o	GRADE	.042	.001	.467	.003	.006	.042
r e	HRS	.048	.002	.355	.115	.100	.350
r f	LHRS	.018	.001	.181	.091	.100	.256
e f	PHRS	.360	.084	.854	.352	.275	.681
l i	ΔATT	*	NA	NA	.020	.003	.456
a c	PΔATT	NA	*	.000	.038	.011	.425
t i	SΔATT	NA	.6666	*	.031	.004	.560
i e	ΔKNW	.1822	.1627	.1687	*	NA	NA
o n	LΔKNW	.2323	.1986	.2224	NA	*	.000
n t	PΔKNW	.0588	.0629	.0460	NA	.3889	*

Tables do not duplicate data. P values are at upper right,correlation coefficients are at lower left.

[a] Owing to missing data, N for all correlations to GPA is 145

logons were not correlated to other variables in this study, they were observed. The mean number of logons per student was 13.202 overall (3 min, 27 max), 6.196 for literacy applications (0 min, 21 max), and 7.006 for pedagogical applications (2 min, 20 max). These averages differ dramatically from student reports of lab usage. This information is already proving to be very useful in reshaping course parameters and student expectations.

Relation of Lab Time to Attitude Change

A number of mild relationships were observed in this area. Total hours and literacy hours were both significantly related to change in total attitude and change in personal attitude, with correlations ranging from .1554 to .2568. There was no significant relationship between pedagogical lab hours and attitude toward school uses, or between this variable pair and the other two pairs.

As Troutman (1991) already observed, attitude has tended not to change much in this course. Student teachers tend to enter the course with positive attitudes toward technology, so there is not much room to improve. Even in this context, however, these findings support the report of Roblyer, Castine, and King (1988) and many others that the act of using computers tends to improve attitudes toward them. The strongest attitude correlation (.2568) was observed between literacy hours and change in attitude toward personal use. This observation held up under a post-hoc regression procedure holding the effect of GPA constant (F=5.309, p=.0227.)

The lack of a similar significant relationship between pedagogical lab hours and attitude toward school use of computers may seem curious in this light. However, an individual's beliefs about how computers can or should be used in schools is probably less strongly rooted in his or her specific skills with computers than is the same individual's beliefs about how computers can or should be used by others. If this is true, then it seems that the attitude toward school uses would be less amenable to change through the acquisition of skills through practice.

Relation of Lab Time to Knowledge Change

As inspection of table 5 indicates, no significant relationships were observed among any of the lab time and knowledge change measures or submeasures. These results continued to occur when the same data were analyzed via a regression procedure that held GPA constant (GPA was significantly correlated to the knowledge change at .2307, p=.005). This lack of a relationship between knowledge gain and lab hours may, indeed, represent a validation of the course design. The knowledge gain instrument is a minimum competency-based measure and so it has a low ceiling. Since a relatively unlimited number of lab hours is available to each student, it is expected that all motivated students are able to attain the same level of performance.

Relation of Lab Time to Course Grade

Mild relationships occurred between lab time and course grade. All three measures of lab time were significantly correlated to course grade (p<=.022), with correlations ranging from .3071 to .1798 (GPA was also significantly correlated to course grade at .4736, p=.000). The seeming discrepancy between the fact that lab hours and course grade are correlated and the lack of a correlation between lab hours and knowledge change may be explained by the fact that knowledge growth as demonstrated on the pre-/post-test is only one component of the course grade. The relationship between lab hours and the successful completion of lab-based assignments and projects (a measure used in computing grades) was probably strong enough to make the overall GRADE/HOURS relationship significant. Nonetheless, knowledge change and course grade were significantly correlated to one another (.2278, p=.003).

Limitations, Conclusions & Future Research

The reader is cautioned to use care in generalizing any results of this study related to the knowledge change instrument. That test has not yet been validated or judged reliable. Also, as discussed above, any inferences made about such results must also take into account the low ceiling on the exam. In generalizing from this population, it is notable that data were collected during the summer session. Even for our college, this sample was probably not a fair representation of the larger population. For example, very few physical education majors (normally a large clientele) were enrolled.

Probably the most striking finding is that, although the general literature is supported in that using computers tends to change attitudes towardcomputers, this finding does not extend to changing prospective teachers' attitudes about school uses of computers. Possibly this difference reflects the difference between what teachers will say about how computers can or should be used in schools, and what school uses they, personally, are prepared to defend or to implement. This finding is important because teacher attitude change toward technology is often cited as an important outcome of introductory computer courses. Possibly the designers of such courses should focus on cognitive outcomes instead.

Whatever the results of this study, an important aspect of it has been the use of a means for objective, unbiased measure of student time using computers. In every other study that the authors were able to locate, such data were either subject-reported or reported by another human observer. The NETLOG program developed for this study has illustrated how to compile such data from ICLAS systems. A disadvantage of this technique was that valuable data were lost from students who worked at home. Surely this missing data influenced the results of the study.

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Structuring teachers' attitudinal changes: A follow-up study

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Introduction

As computers and related technologies become increasingly woven into nearly every aspect of daily life, it is only natural to expect that they would become an integral part of the educational system as well. The promises of yesteryear indicated that computers would revolutionize education and produce generations of technologically literate independent thinkers required for transformation into the Information Age. Seymour Papert suggests these two theses in his introduction to *Mindstorms* (1980): "...The computer presence will enable us to so modify the learning environment outside the classrooms that much if not all the knowledge schools presently try to teach with such pain and such expense and such limited success will be learned as the child learns to talk, painlessly, successfully, and without organized instruction." (p. 9). While not advocating the abolition of schools, he was suggesting that schools must be able to adapt in form and function to a rapidly changing technological world.

Yet today, twelve years later, in many schools integration of the computer into the classroom has been minimal, characterized by limited use of the technology as an add-on rather than as integral to teaching and learning (Zappone, 1991) The overall effect appears to be merely a ripple on the surface of the system while education continues as it has for the past several decades.

One problem is that the growth of computer usage by the schools was neither preceded nor accompanied by a plan; the past ten years or more have been an age of experimentation. To compound this problem, the technological horizons are moving so fast that today's techniques and even today's concerns are often outmoded by tomorrow. Many teachers, while being bombarded with promises of tomorrow's technology, are still struggling to make efficient and effective use of yesterday's hardware and software. Current practice is rooted in the limitations of these older resources and in lack of training.

In more recent years, an emphasis has been on the use of the computer as a tool to achieve curricular objectives. The development of Integrated Learning Systems (ILS), beginning with early systems such as Plato, has exploded with the introduction of multimedia technology. Certainly, newer hypermedia technology has potential, but even more traditional software can be integrated into classroom practice. The most often cited barriers to this integration are lack of resources, and lack of training (OTA, 1988; Knupfer, 1989).

Approaches to teaching are generally modeled after those teaching styles observed and experienced. Teachers tend to teach as they were taught, modified by experiences in the pre-service education curriculum. With respect to computer integration, few teachers used technology in their own collegiate education, let alone pre-collegiate education. Casual observation suggests that the level of computer sophistication of faculty members in many education departments is not much better.

According to the report *Power ON!* from the Congressional Office of Technology Assessment (OTA, 1988), only one-third of the nation's teachers have had as much as ten hours of computer training. Most of this training has been about computers rather than about how to teach with computers. The response from teachers has been that this type of training leaves them with an overwhelming realization of the necessity to learn more.

While access to resources and training have been considered necessary for integration of computers into teaching and instruction, support is a third element that is often overlooked. In this respect, administrative support is the key to access and training (Jongejan, 1990). Another type of support often lacking is follow-up support beyond initial training periods (Hall & Hord, 1987).

Project CHOICE: Curricular Help On Integrating Computers In Education

Recognition of the importance of training, support, and resources to the integration of computers into the curriculum was the cornerstone of the Project CHOICE design (Bauder, Planow, & Sarner, 1990) The two year program was offered at the State University of New York Institute of Technology at Utica/Rome, beginning in June, 1990. It was funded through a grant from the U.S. Department of Education's Office of Educational Research and Improvement through the secretary's Fund for Innovation Program (PR/Award # R215A92073).

This comprehensive program aimed to help teachers acquire the skills necessary to integrate the use of the computer into the curriculum and to ensure that resources and support would be available as necessary. To do so, the project went beyond the traditional inservice training workshop.

Central to the project was the development of four graduate level courses for teachers and the provision of software and related hardware (interface boards) to their schools. For the first year of the project, courses were designed using software based on the Logo programming language (LEGO Logo and LogoWriter). The primary reason for this choice was that these products can be used for a wide range of grade levels, subject areas, and teaching methods. Also, the products chosen are available for the type of equipment most commonly found in today's schools, and do not require extensive retraining to adjust from one platform to another. For the second year of the project, a course using a presentation graphics package and video output capability was added.

Support for the teachers was two-fold. The two-week intensive summer courses were augmented by follow-up meetings during the school year and by on-site visits by the Project CHOICE team. These facets of the program gave participants the opportunity to share experiences and concerns with each other and with project staff.

School-based support for the project was also important. Participating teachers were selected through a process that required signatures of support from administrators and union leaders (where teachers were represented by a union). This ensured that teachers would be given release time to attend follow-up meetings, and would be allocated resources and time to field test lessons and materials developed through the project.

Teachers were expected to develop and test at least one lesson using the software and to offer inservice training in their home districts or through the local teacher center. No specific requirements for inservice training were given as this is often a locally controlled contractual agreement.

In the first year of the project, June, 1990 through June, 1991, 36 teachers in 34 different schools representing 24 districts participated. Teachers represented nearly all grade levels and subject areas and came from a 100 mile radius of Utica, although most were from the Utica/Rome area. Thirteen teachers were enrolled in the LEGO LOGO course and 23 took the LogoWriter course.

June 1991 began the second year of the project with forty-two teachers representing over thirty districts. Seven of those teachers had also participated in the first year of the project.

Methodology

A pre- and posttest questionnaire was developed to measure teachers' attitudes towards the educational use of computers, their own perceived comfort and knowledge levels, and their perceptions of the level of support and planning in their districts. The questionnaire was administered to teachers at the beginning of their participation in June of 1990 or June of 1991, and again at the end of their year of participation (May 1991 or May 1992).

Participant attitudes were measured by reaction to eighteen statements along three dimensions: (a) general attitudes with respect to computer use, (b) level of comfort with respect to computer use, and (c) perception of their skill level. Statements were both positive and negative to detect response biases and responses were coded on a directed nine point scale. Twenty-nine of 36 participants in the first year and 28 of 40 participants in the second year completed both the pre- and post-test questionnaires.

Since a central premise of Project CHOICE was that attitudes would be altered as a result of participation, analysis of each item necessitated excluding cases in which the participant indicated the most favorable outcome for an time on the pre-test. Thus, for example, a participant who indicated complete agreement with the statement "All teachers should be skilled users of microcomputers" would be removed from analysis of that item, since it was not possible to improve the score of a respondent already at the ceiling. The remaining pool of respondents were included in t-test analyses using paired samples.

Results

Seven of the questions probed general attitudes with respect to computer use. Typical of this group were statements like "Microcomputers are important pedagogical tools", "Microcomputers can assist the teacher in accomplishing a wide variety of educational tasks", and "All teachers should have a microcomputer in their classroom". On all of these items, no significant change was observed in at least one of the two years, and the pattern was inconsistent. This lack of change was not unexpected, as the selection process began with self-nomination by the teachers within their own school district. The participants would not have been likely to become involved in this type of project unless they already felt that computers were worthwhile tools. Once the participants were nominated, they had to be endorsed by their administration and by the bargaining agent. If either of these did not feel that a potential participant was appropriately motivated, it is not likely that the nominee would have been granted the necessary support by the school district to participate in the program.

Two of the questions dealt with participants' comfort with respect to computer use. On the first, "In general I feel comfortable using microcomputers to accomplish educational goals/objectives, 12 of the 29 respondents in year one and 10 of the 28 respondents in year two indicated complete agreement with the statement. The degree of change in the remaining participants was not significant in the first year, and was significant at the .01 level in the second year. Again, the selection process caused only those with a fair amount of comfort using the computer to participate. The other question asked the participants to compare their comfort level with those of their peers. The change in this item was significant ($p < .01$) in both years. This change could be seen as a result of the multiple facets of Project CHOICE. The intensive two week summer course was a major catalyst. It was designed to involve more than 45 hours of hands-on training—an amount that far exceeds the usual inservice course offerings. In addition, the project team served as a support group for the participants once they went back to their school districts. The team answered questions over the phone and went on site to solve problems when necessary. While not many of the participants took advantage of the support, several expressed a sense of security that it existed. The follow-up sessions held throughout the school year also gave participants a chance to ask questions and get help if needed.

The third dimension of the questionnaire, consisting of seven items, was concerned with participants' perception of their own microcomputers skills. By far the most concrete of the three dimensions, skill level is also the most easily altered. It was in this dimension that Project CHOICE scored its most notable and consistent successes. Typical items in this area were "I am not knowledgeable enough about microcomputers to make effective use of them in the classroom", "When I face a new educational problem or task, I have sufficient knowledge to integrate the microcomputer in the accomplishment of the task", and I know enough about microcomputers to teach others in my school/district." With the ceiling effect again controlled for, significant results ($p < .05$) were achieved on six of the seven items in both years.

Changes in this dimension are most likely to be associated with the intensive summer course and follow-up support. Another possible component is that of access, both for teaching and for preparation. Participation in the program required that teachers be given sufficient resources to incorporate materials developed into classroom use. For some, this meant regular access to computers in the classroom or lab for the first time. In addition, responding to feedback from first year participants, the Project CHOICE staff facilitated summer loans of computers from districts for second year participants. This enabled participants to continue working throughout the summer and not lose the momentum of the intensive course.

The sole item on which significant changes did not occur was "When I use a microcomputer in the classroom, it usually because someone else has shown me how to do it." Teachers may attribute their own growth in skill level to the course work and to experiences shared with peers during the follow-up sessions.

Project CHOICE was effective in raising the skill levels of participants. The assumption that they would bring to the program positive attitudes and a relative level of comfort in using computers was substantiated. Because these participants were sophisticated, having had considerable experience in computer usage, it is not surprising that attitudes and comfort level did not change appreciably. As participants were exposed to new, integrative computer activities, and as their skill levels were enhanced, our evidence suggests that they discerned distinct performance differences between colleagues using computers and those who did not. Furthermore, all three items calling for peer comparisons showed increases in participants' perceived competency relative to their peers. The change literature suggests that the full impact of intervention programs will not be immediately evident. Work in progress will examine diffusion patterns in the participants' schools and will relate them to teachers' perceptions of conditions associated with technological change.

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Research on educational telecomputing: Collecting data via computer

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Telecomputing Systems and Teacher Education

According to John Clement (1992), director of EDUCOM's K-12 Networking Project, there has been significant growth in the number of educators with access to educational telecomputing networks (e.g., electronic mail, bulletin board, and computer conferencing systems), as well as growth in the number and quality of such networked educational resources. Of particular importance is the increased number of K-12 educators with access to the Internet, a collection of hundreds of interconnected national, regional, and campus computer networks which obey a common communications protocol (Arms, 1991). Clement estimates that the number of K-12 educators with access to the Internet will surpass 50,000 by mid-1993. The addition of K-12 teachers (and students) to the Internet, which already links most major universities, signifies the beginnings of the formation of "a seamless computing network extending from kindergarten through graduate school" (Bull & Anderson, 1991, p. 108).

Such a network has implications for preservice and inservice teacher education and professional development. It can increase opportunities for interaction and collaboration among, and ultimately development of communities of, K-12 teachers, preservice teachers, and teacher educators. Also, telecomputing may be used in education courses as a means of instructional delivery, as a vehicle for interaction among students and instructors, and as a topic of instruction. In addition, it may be used to provide support for field experiences, student teaching, and the induction of first year teachers.

The increase in the availability and use of telecomputing networks in education raises numerous issues about how they can best be implemented, how they can be effectively applied, how positive outcomes can be facilitated, and how negative outcomes can be avoided. Researchers may be interested in finding answers to questions such as: How and why do educators use networks? What factors are associated with network usage? What are the positive and negative outcomes of network use? What factors affect such outcomes?

Telecomputing Systems and the Research Process

According to Rogers (1986), new communication technologies such as computer-mediated communication systems affect research methods in two ways: they make possible the study of new research problems, requiring modifications in existing research methods or use of new methodologies, and they allow new methods of gathering and analyzing data. Telecomputing systems can be used to initiate data collection (e.g., administer online surveys or experiments) as well as to unobtrusively monitor usage behavior. In this way, the medium itself is used as a vehicle for studying its use.

System as Initiator

Electronic surveys have been found to be an effective means of collecting data. In general, return rates have been comparable to or somewhat lower than those for face-to-face interviews or mailed questionnaires. Sproull (1986) found no significant difference between the participation rate in an electronic mail survey (73%) and that for face-to-face interviews (87%) with experienced electronic mail users in a business setting. Similarly, Kiesler and Sproull (1986) obtained a response rate of 67% for an electronic survey and 75% for a paper-and-pencil survey with active electronic mail users who were students faculty, and staff at a private university. Also, Rafaeli (1986) obtained a response rate of 48% for an online survey and 82% for an identical mailed survey conducted in a university setting. Computer-monitored data indicated that the low response rate could be attributed to the fact that many users did not read their electronic mail during the survey period.

System as Monitor

Most telecomputing systems routinely collect usage data, such as the frequency and duration of online sessions, for maintenance or accounting purposes. Usage data collected by a computer system is typically more accurate and reliable than self-reported usage data, which has been shown to vary, sometimes considerably, from actual behavior (Bernard, 1984; Rice, 1990; Rice & Shook, 1988). Only moderate, but nevertheless significant correlations have been found between self-reported and computer-monitored usage data for frequency of log-ons (r = .29, Ettema, 1985) and amount of connect-time (r = .38, Rice & Shook, 1988).

Although it may be more reliable, computer-monitored data is not necessarily more valid (Rice, 1990; Rice & Shook, 1988). For example, amount of connect-time does not indicate whether a system has been actively used. Both frequency and duration data may be influenced by whether one can maintain an idle connection to the system or must log-out (or be disconnected) after a certain amount of time. In addition, users with greater system experience may compose their messages offline and then upload the content, thus seeming to use the system for less time than they actually do (Harasim, 1987).

An Illustration: The Free-Net Study

A methodology for using a telecomputing system for data collection was developed and tested in a study of factors related to usage of a community telecomputing system known as the Cleveland Free-Net. Data was collected by using the Free-Net's electronic mail system to transmit a 72-item survey. In addition, computer-monitored data was used to develop the sampling frame, to determine the number of people who actually received the survey, to compare the usage rates of respondents and non-respondents, and to compare self-reported and computer-monitored measures of amount of system usage.

Sampling

Computer-monitored data was used to generate the sampling frame, from which a sample of 600 was randomly selected. The Free-Net system operator provided log files containing the user ID, date, time, and length of each session over a two-week period immediately prior to the survey mailing. From these files, a list of the user IDs of people who had logged onto Free-Net at least once during the two-week period was derived. The random sample of 600 user IDs was drawn from the sampling frame of 4887 user IDs by using the Statistical Package for the Social Sciences' (SPSS) "SAMPLE" command.

Procedures

Initial mailing. Procedures for administering the e-mailed surveys were adapted from Dillman's (1978) "Total Design Method" (TDM) for mailed surveys. A cover letter and a 72-item questionnaire was sent to 600 individuals via electronic mail. Although it would have been much quicker to mass mail the surveys (by including multiple e-mail addresses on the address list of a single message), the messages were instead sent individually in order to personalize the survey. Each person's first name was typed into the greeting of a cover letter which introduced the questionnaire and attempted to motivate individuals to respond. Macros were used to speed the process. Nevertheless, the initial mailing took about 12 hours.

In accordance with standard procedures for protection of human subjects, survey recipients were informed that their participation was voluntary and that they could notify the researcher at any time if they did not want to be contacted again. They were also told that their responses would be kept confidential. One problem with e-mailed responses is that they cannot be anonymous because the sender's name and user ID are automatically attached to every message he or she sends. Thus, when completed surveys were received, identifying information was separated from responses and replaced with a random ID number.

Directions for several methods of completing and returning the survey were provided at the beginning of the instrument. So that users without the technical expertise needed to complete the survey electronically were not excluded, they were given an opportunity to request that a survey be sent to them by postal mail. Options for responding to the survey included:

1. Using an online editor (e.g., Emacs or VI) to edit in answers and returning the survey via e-mail.
2. Downloading the form, editing in responses using a word processor, uploading the completed form, and returning it via e-mail.
3. Printing out the survey, then reading the questions from the printout while directly entering the number of each question followed by a response in an e-mail message.
4. Printing out the survey, writing in the answers, and returning it via postal mail.
5. Requesting that a paper copy of the survey and a stamped return envelope be sent via postal mail, then writing in responses and returning the survey using the envelope provided.

Overall, these directions seemed to work well. Occasional problems included garbled responses and parts missing from the survey, most likely due to technical problems or using a method without fully understanding how to do it properly (e.g., not knowing that a file to be uploaded must first be saved as an "ascii" file). These problems might have been reduced by encouraging respondents to request a conventional paper survey, which did not require any technical skills to complete.

Follow-ups. According to Dillman (1978), without follow-up mailings, response rates would be less than half those normally attained using TDM. Each follow-up mailing served as a reminder to non-respondents and used a slightly different approach and successively stronger appeals for the return of the survey. As with the initial mailing, the follow-up messages were sent individually and each person's first name was typed into the greeting of the message.

Dillman (1978) recommended that follow-ups be sent at one, three, and seven weeks from the initial survey mailing date. However, because there is essentially no delay in transmitting electronic surveys (and because of external time constraints imposed upon the researcher), the time interval between follow-up messages was shortened to approximately one week intervals. Negative feedback from some participants suggested that some of them felt they were being unduly rushed. (Conversely, other respondents apologized for delaying their response!) Thus, a slightly longer interval (perhaps one, two, and three weeks, respectively) should probably have been employed.

Data Coding. One of the advantages of electronically administered questionnaires is that they allow all or part of the data coding to be automated. Surveys in which respondents edited in their responses could usually be coded by computer, whereas others had to be coded by hand in the usual manner. Responses to open-ended questions also had to be hand-coded (cutting and pasting from one file to another worked well for e-mailed responses, whereas written responses had to be manually transcribed). Although the automated process did not work perfectly and could not be used with all of the surveys or for all of the responses, it did save a considerable amount of time and labor.

To allow automated coding, respondents who chose to edit in their answers to the survey were directed to place their answers after a "==>" prompt. Each completed survey was saved as a separate file. A computer program was written to extract the information after all the "==>" prompts in each file and place it in another data file in a

Table 1
Survey Response Rate Over Time

Procedure	Date	# Returned	% Returned	
			Surveys Sent[a]	Surveys Received[b]
Survey mailing	5/27-8	93	16%	19%
1st follow-up	6/02	114	19	24
2nd follow-up	6/09	65	11	13
3rd follow-up	6/17	48	8	10
Total by	7/17[c]	320	53	66

[a] N = 600. [b] n = 483. [c] Ten more surveys were received after this deadline, but were not included in the analysis.

format that could be processed using SPSS. Data that was coded in this manner was checked carefully and errors were corrected by hand. The most common source of error was answers that were not placed to the right of the "==>" prompt (e.g., on the line above or below the prompt).

Results

Response rate. Rather than calculating the percentage of the total sample that returned completed surveys, the response rate was calculated by determining the percentage of the sample that had read electronic mail during the survey period who returned completed surveys. Thus, unmade contacts were excluded from consideration. According to Dillman (1978), this procedure is frequently used and provides a more direct indicator of a method's response-inducing capabilities.

Three hundred and twenty people completed the questionnaire (78% of these were returned via electronic mail and the rest were returned via conventional mail). Computer-monitored data provided by the Free-Net operators indicated that 117 of the 600 people who were sent questionnaires did not read their electronic mail during the survey period. Thus, the response rate based upon the number of users who actually received the survey was 66%.

As shown in Table 1, the majority of the completed surveys were returned within the first two weeks after the initial survey mailing. Each follow-up was successful in drawing additional responses, with the earlier follow-ups drawing more responses than the later ones. Overall, the data collection process proceeded relatively quickly, lasting approximately two months in total.

Response bias. Comparisons were made between respondents and non-respondents using the computer-monitored data from the log files for the two-week period prior to survey mailing. These comparisons indicated that respondents were more likely to use the system more often and for more time than were non-respondents. As shown in Table 2, there were significant differences between respondents and non-respondents for the total number of log-ons, average session length, and total amount of time spent online during the two-week period.

Comparisons were also made among surveys returned during four different time periods. The rationale for this analysis was that late-respondents would be similar to non-respondents. Thus, by extrapolation, significant differences among groups based upon the survey return date suggested possible differences between respondents and non-respondents. Significant differences among the four groups were found for system accessibility ($F = 6.39$, $p < .001$), as well as for frequency of log-ons ($F = 4.20$, $p < .01$). Those who returned the survey within one week of the survey mailing were more likely to perceive the system as being easy to access than were those who returned the survey later. Thus, it is probable that non-respondents were also more likely to perceive the system as more difficult to access as well as to log-on less frequently than were those who did return the survey.

Accuracy of usage data. Comparisons were made between computer-monitored data from the log files for the two weeks prior to survey mailing and self-reported

Table 2
Descriptive Statistics and t-tests for Computer-Monitored Usage by Respondents and Non-respondents

	Mean	SD	t	p
Log-on frequency				
Respondents[a]	16.54	26.01		
Non-respondents[b]	7.39	12.99	-5.54	< .001
Session length				
Respondents	19.08	23.03		
Non-respondents	14.69	14.04	-2.85	.004
Total duration				
Respondents	6.07	13.09		
Non-respondents	2.20	5.38	-4.84	< .001

Note. The identity of 2 respondents could not be determined, thus they are included in this analysis as non-respondents.
[a] N = 318. [b] N = 282.

usage data obtained from survey questions asking about the frequency and duration of Free-Net usage during the "past two weeks." Correlations were calculated between computer-monitored and self-reported measures for all surveys, as well as for surveys returned during the first-two weeks after the initial mailing (since these responses corresponded most closely to the time period covered by the log files) and also for surveys returned after that time. The correlations ranged from .42 to .60 for log-on frequency, from .34 to .55 for session length, and from .17 to .60 for total time online. In each case, the correlations were highest for the portion of the sample that responded during the two weeks closest to the time period in which the computer-monitored data was collected.

Discussion

The methodology employed in the Free-Net study appeared to be effective, overall, while probably requiring less time, labor, and money to administer than would a conventional mailed survey. The current response rate fell within the range (from 50% to 93%) usually obtained by surveys employing TDM (Dillman, 1978). A response rate of 66% is typically considered as "good" (Babbie, 1990). However, it was slightly lower than the response rate of 73% obtained by Swift (1989) in a previous mailed survey of Free-Net users. Previous research has indicated that response rates for online surveys can be expected to be the same or somewhat lower than those for face-to-face interviews or mailed questionnaires (Kiesler & Sproull, 1986; Rafaeli, 1986; Sproull, 1986).

The use of a probability sample in this study (as opposed to the many e-mailed surveys that I have seen which have been broadcasted to an unknown number of unidentified recipients) reduced the chances that the sample findings differ from "true" population values. Comparisons made between respondents and non-respondents using computer-monitored data, as well as comparisons made between early and late-responders, provided a means of assessing the extent to which non-response created biases in the survey findings. The comparisons suggested that the respondents may under-represent infrequent users and those who perceive the system to be difficult to access. By having information about such biases, the researcher can predict the way(s) in which the sample findings may differ from "true" population values and the way(s) in which these differences may have affected the analyses. In the present study, it appeared that the range of responses on usage and system access variables was probably restricted and thus the magnitude of some of the relationships observed may have been lower than they would have been otherwise.

In order to minimize problems involved with self-reported data, which is not often very accurate or reliable, Rogers (1986) recommends obtaining multiple measures of system usage from several independent sources, including computer-monitored data. In the present study, computer-monitored data provided a means of judging the accuracy of self-reports of system usage. Although the correlations obtained (r =.17 to .60) were, with one exception, better than those obtained in other studies (r = .29 to .38, Ettema, 1985; Rice & Shook, 1988), there were still considerable differences between the usage data obtained from the two different sources. It would have been even better to have computer-monitored data for the entire time period in which the survey data was collected. This data could have been used to augment or replace the self-reported usage data.

Telecomputing Systems and Educational Research

The methodology used in the Free-Net study may also be appropriate for research investigating usage of educational telecomputing networks by K-12 teachers, preservice teachers, and teacher educators. Adaptations to the procedures may be made based upon consideration of factors such as school calendars and the characteristics of a particular network and its users. Pilot studies should be conducted to determine whether an acceptable response rate can be achieved by using this method in an educational context.

The appropriate population for an electronic survey includes users with adequate access to the network and sufficient experience with computers and telecomputing, in particular, so that they feel comfortable using these technologies. Indeed, 86% of the Free-Net study respondents reported easy access to computers and modems with which they could access the system, although about half reported having difficulty making a connection the Free-Net itself. Furthermore, 82% of the Free-Net study respondents had more than 5 years of experience using computers, although less than half had been using the Free-Net for more than a year.

Given that appropriate conditions exist and necessary adaptations can be made so that an acceptable response rate can be achieved, the methodology illustrated by the Free-Net study offers researchers an opportunity to study usage of educational telecomputing networks (and possibly other topics) in a manner that seems to require less time, labor, and money than would a conventional mailed survey.

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Chaos and education

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Perspective

To some, chaos is a disturbing, and unsettling concept. It takes us from a world of predetermined order, mechanistic certainly and reductionism to a world of geometric structure masquerading as randomness and unpredictability. It is a world that metaphorically might exist behind Alice's looking glass. When looking into her mirror, remarks that's just the same as our (world), only the things go the other way (Carroll, 1871). We might say the same thing when observing the seemingly strange world of chaos where randomness is not random and predictability is not predictable. Strange attractors, bifurcation points, phase space, and fractals are just some of the artistically-crafted terms used in this exciting frontier (Gleick, 1987). It is a frontier that crosses many academic disciplines and signals a change in the way we should view education. It is a frontier for those who seek to understand complex, constantly fluctuating systems - systems such as the 100 trillion connections of the 12 billion neurons that comprise our brain.

Our education system assumes a mechanistic world where all learn in lock step fashion. We have built a system based upon the needs of an industrial age, where everyone in the system is expected to learn the same thing at the same time, and progress through a linear sequence of activities both micro and macro. This is not the kind of schooling systems we need for the information age. What we teach our teachers about learning is anachronistic. Current teacher education curriculums are, for the most part, based upon philosophical concepts brought forth hundreds of years ago to accommodate the industrial age. It is an age that no longer exists.

The Newtonian research model, so completely and unquestionably adopted by education early in the 19th century, and almost universally accepted by educators today may no longer be a viable scientific model for education. Absolute determinism must now yield to constructionism, complexity and the seemingly unpredictable. The statistic of the average and the wholesale reliance on linear models has, no doubt, contributed to our knowledge of the schooling process. But our blind acceptance of this mechanized, deterministic model has also led us away from an information age educational system. We must seek new methods to build nonlinear models that provide us with a true and accurate representation of learning. We must look at all aspects of our education system, striving to build an education system built upon sound scientific principles. We must invent a new science of education.

Theoretical Framework

Learning and thinking are nonlinear processes. In fact, very few processes in the world are linear. Life itself is nonlinear. Where we educators are at fault is in trying to fit human behavior into a linear measurement system. As such, we miss probably the most important elements of the systems we study. We falsely attribute learning behaviors to one or two factors and then build instruction to incorporate these factors. Although we try to control all other factors through mostly linear statistical procedures, we fail to recognize the value and importance of the nonlinear events.

Another serious oversight that educators make is in assuming that small differences in the initial state of the learning process has little or no effect upon the resultant outcomes of instruction. We assume that any differences that do exist initially will average out overtime. Sometimes when we do recognize that the differences matter, we believe that we can control or at least account for them by applying linear statistical measures. Chaos tells us otherwise.

One of the cornerstones of chaos is that small initial differences in a dynamical system can produce enormous differences in the outcome of that system. These differences in outcome are largely unpredictable. This phenomenon called *sensitive dependence upon initial conditions* was initially discovered in 1960 by Edward Lorenz who was studying weather patterns for the purpose of deriving a method to predict the weather. Having gathered data on one run, he decided to repeat the calculations using the same data. To his surprise, the results of this second run began to diverge rapidly from the first run. Although the equations for the two runs were the same, he chose to round off the figures from the first run from six to three decimal places for the second run. While the differences between the two inputs was only a fraction of a percent, the difference in the outcomes became incredibly large in a short time. From the same set of data Lorenz saw the prediction of two vastly different weather systems (Briggs & Peat, 1989).

Up to that time, it was commonly assumed that these small differences in the initial condition of a dynamical system could be ignored because of the belief that they would eventually cancel out through an averaging process. Lorenz's experiment put to rest the assumption. His discovery now popularized as an aphorism states that if a butterfly flaps his wings in Hong Kong, a thunderstorm could form in New York several weeks later. That is, small initial differences do indeed lead to large and sometimes chaotic terminal effects not easily predicable. This leads us to the inescapable conclusion that predictability, the kind we do in education, is an elusive creature fraught with error.

It is important for educators to recognize that the study of education is essentially a study of a dynamical system. From the firings of the synapses in the brain to a school's economical conditions, chaos is there. We know that very simple nonlinear systems contain a rich spectrum of dynamical behavior (May 1976). As such, teacher educators can no longer ignore the implications of chaos in the design, development and evaluation of curriculum and the schooling process. As we become more and more dependent upon the computer to study and deliver education, we must be aware of the implications due to chaos in these systems, and use the computer to help us discover chaos within the schooling process.

Summary and Conclusion

We have tried to introduce the reader to very brief overview of chaos theory stressing that many aspects of our education system are dynamical systems requiring nonlinear solutions. In particular, thinking, reasoning and learning are nonlinear. The brain itself is a dynamical system made up of individual neurons forming incredibly complex networks that represent information, knowledge, perceptions, emotions and thought. Chaos theory can provide us with powerful tools to study these complex systems.

We suggest that the traditional linear methods used in educational investigation and development are inappropriate for 21st Century teacher education. Education must move away from traditional linear mathematics and move toward the study of nonlinearity and complexity. No matter how intricate we make our linear mathematics and statistical procedures (multiple linear regression, etc.) they cannot compensate for our ignoring the nonlinear world we live in. As professional educators, we have failed to present this view to our students. This results in teachers and administrators who are ill-equipped to deal with the complexity inherent in most of our educational endeavors. Graduates of teacher education programs must become mathematically literate and schooled in the procedures of nonlinear dynamics and its consequences. They must understand that learning is not a series of sequential events, but a process of information transfer that follows the rules of complexity.

We hope this brief discussion of chaos theory will stimulate other educators to pursue investigations into how chaos theory might be used to study human learning, design instruction and operate 21st Century schools. We encourage others to expand on the ideas presented.

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Conducting technology and teacher education research: The STATE Monograph

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This article introduces the recent monograph, *Approaches to Research on Teacher Education and Technology* (Waxman & Bright, 1983). This monograph was commissioned by the Society of Technology and Teacher Education, a division of the Association for the Advancement of Computing Education. The monograph highlights some of the recent work of researchers in the field of technology and teacher education and examines typical research approaches and methods that have been used in the field as well as paradigms or conceptualizations of research in technology and teacher education.

It is important to examine research methods and paradigms in technology and teacher education is important because in educational research, the answers we develop are shaped by the: (a) form of questions we ask, and (b) methods we use to resolve them (Clark, 1979). Unfortunately, investigators' personal commitments to a given research methodology have sometimes guided and shaped the research process by affecting their choice of design, instrumentation, and interpretation of data (Dunkin & Biddle, 1974). In other words, the selection of the research method is often related to the theoretical or ideological commitments or beliefs of the investigator (Shulman, 1981, 1986). As Kaplan (1963) describes it, "it comes as no particular surprise to discover that a scientist formulates problems in a way which requires for their solution just those techniques in which he himself is specially skilled" (p. 28). Awareness of a variety of research methodologies and paradigms can broaden our approach and perspective on research problems and change our ways of thinking about what we can study and how we can study it (Kerlinger, 1977).

Research Methods and Paradigms

A research methodology is a specific technique or strategy of inquiry, while a research paradigm is a matrix of beliefs and assumptions about the nature and purpose of a phenomenon that gives shape to specific forms of inquiry (Zeichner, 1983). As Padilla (1990) describes it, "a scientific 'paradigm' orients and guides the thinking about researchable problems, theory, methods, and interpretation of data" (p. 18). A paradigm is an accepted and shared model of research where the same rules and standards are applied (Kuhn, 1970). It is a way of conceptualizing research that represents the perspective of the researcher toward the problems being studied. According to Reichardt and Cook (1979), "a paradigm includes not only a philosophical world view but also a linkage to certain type of research method" (p. 11). Consequently, the paradigm determines the research methodology. This monograph's dual emphasis on methodologies and paradigms allows educators to understand how theoretical considerations determine the appropriate analytic tools that should be used in research in technology and teacher education.

We do not know at this time how technologies might influence the future development of research methodologies or paradigms for the study of teacher education in general or technology and teacher education in particular. It is certainly possible that there will be critical and deep changes in the ways we think about teacher education research. The intent of the monograph was to move the discussion of these issues forward so that future research would be significantly more valuable than it is today.

Overview of the Monograph

This monograph is divided into two parts. Part I, Overviews of Research Programs and Perspectives, addresses several specific frameworks and approaches for research on technology and teacher education. Although the chapters in this part are quite diverse, they draw together some of the potential directions for research in technology and teacher education. In the first chapter, Cleb Maddux describes past and future research stages in educational computing and argues that research now needs to ask which and how learner and learning variables interact with teaching variables as they relate to specific dependent variables. In the next chapter, Rich Johnson reviews recent research findings that address technological media and how its implementation into educational contexts affects student learning outcomes. Jerry Willis follows with a proposal for teacher educators in the area of technology to change their research focus from a Research-to-Support-Theory Model to an Instructional Development Research Model. Next, Doug Brooks proposes a systems integration approach for researching the role of technology in professional development. In the last chapter of Part I, Lamont Johnson and Steve Harlow describe some current research in technology and teacher education and argue that there are three phases of our mission, (1) acquiring and developing technology, (2) integrating technology, and (3) engaging active conversation with public school practice.

Part II, Methods of Research in Technology and Teacher education, focuses on specific research methods and on how they have been used in technology and teacher education. Although the chapters in this part do not review all of the potential methods for conducting research in technology and teacher education, they do represent most of the methods that are generally used in this area. In the first chapter, Kip Tellez describes experimental and quasi-experimental research in technology and teacher education and argues that there should be more quality experimental research in this area. In the next chapter, Gregg Brownell summarizes two types of descriptive research: (a) survey research and (b) content analysis research. He outlines the concepts, techniques, and provides examples for each type of research. Cliff Liao and George Bright describe the meta-analytic research method and focus on the types of research questions that might be addressed by using that method in technology and teacher education. Diane Novak provides an overview of qualitative research methods and describes features of ethnographic research. She also provides a specific example from a study that illustrates how ethnographic research can inform teacher education. In the last chapter of Part II, Nita Copley and Susan Williams describe the use of systematic classroom observation in technology and teacher education research and argue that its use needs to be expanded in this area.

In the final summary chapter, The Future of Research on Technology and Teacher Education, some of the future research trends and directions in technology and teacher education are discussed. In particular, Bright and Waxman suggest that there are three ways technology can be used: (a) to teach teachers about technology, (b) to improve the delivery of current teacher education programs, and (c) to restructure teacher education. They argue, however, that the use of technology to restructure or change teacher education should be the most important focus. They also discuss some methodological advances and how improvement in analytic techniques can also change research in the field.

Improving the Research in Technology and Teacher Education

Approaches to Research on Teacher Education andTechnology illustrates ways we can use research to improve the effects of technology on teaching and teacher education. The purpose of the monograph is to make available information for improving our understanding of the problems as well as solutions to problems related to research in technology and teacher education. As Walker (1992) puts its, "these are interesting times for anyone concerned with the methodology of research in education" (p. 98). He further adds that "the old order based on an empirical-scientific-positivist doctrine has lost its grip on the field, and no new doctrine has yet achieved dominance, so the educational researcher planning a study today faces an open field bright with possibilities" (p. 98). Given the large number of appropriate methodological options that researchers have in designing their studies, we may now start to see more and better research in technology that contributes to educational improvements.

Research currently has a major impact on all aspects of education, including that of technology and teacher education (Waetjin, 1991). We maintain that research can play a critical role in improving the role of technology in teacher education. Although recognition of the uniqueness of each teacher education program, school, and classroom situation will always need to be considered, the accumulation of research evidence over time and across studies may provide consistent findings that enhance our understandings of the role of technology and teacher education. In other words, more and better research in this field may allow us to change and improve the education of teachers and consequently improve the education of students.

The general public and policymakers have often not had confidence in the research findings of educational researchers because of the contradictory conclusions often presented by different studies using different analytic methods or research methods. Although research syntheses and meta-analyses have alleviated some of these concerns, researchers must still explain the advantages, disadvantages, and appropriate uses of the methodology they employ. Only then, will educators begin to understand the complicated role that methodology has in educational research. We hope at the same time that policy makers will continue to acknowledge the contribution that education research can have in formulating policies that effectively support improvements in schools, classrooms, and teacher education programs. Research is a vehicle that can enhance educational change, but we must be aware that in order to impact practice, research must be effectively communicated and disseminated.

Improving the research on technology and teacher education, however, will take more than just awareness of the problems and knowledge of some solutions. Methodological rigor and sophistication are only one component of excellence in education (Walker, 1992). We will also need a commitment towards quality research and a call to action for collaboration among educators who have different paradigms or perspectives about research in the field. A broad, interdisciplinary research agenda will need to be collaboratively developed and then carried out vigorously. It will need to include both basic and applied research as well as long-term and short-term programs. This process will also require a change in attitudes that will make us all aware of the severity of the problems associated with faulty research and seriously committed to improving the research in technology and teacher education. The monograph was intended to be a step in that direction.

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Section Editor:
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MATHEMATICS & SCIENCE

Technology in Mathematics and Science Teacher Education

The papers in this section of the *Computer Annual* reflect recent changes in conceptualizations of teacher education. Comparison with earlier *Annuals* will reveal trends not only in the study of teacher education but also in the understanding that has developed about how teachers can be assisted in making the changes necessary for integration of technology into mathematics and science instruction.

Theoretical Foundations

The studies reported this year all use explicit theoretical frameworks, either for the conceptualization of the project or for the interpretation of the results. The most popular framework is the use of hands-on or problem-solving experiences in support of learning. This framework is particularly important for mathematics and science teacher education because of its consistency with the numerous reforms suggested for the improvement of mathematics and science instruction across K-12. Other clearly articulated frameworks, however, are constructivism and the Concerns Based Adoption Model. Further use of these frameworks will help connect technology teacher education to other areas of teacher education (e.g., general elementary). It is encouraging that scholarship in the area of technology and teacher education has moved into the stage of conscious, careful conceptualization of explicit frameworks. Further development of frameworks more closely tied to technology (as opposed to borrowed from other areas of educational research) would likely improve even further the research on technology and teacher education in mathematics and science.

The K-12 inservice projects reported in this section reflect understanding of the importance of collaboration, either among teachers for the purpose of changing instruction or among researchers and teachers for the purpose of documenting results. Generally, inservice projects expected that teachers would participate in teams. This approach seems to be explicit recognition that reforms in the integration of technology into instruction will occur only when tools for carrying out those reforms are put in the hands of the people who make the changes - namely, classroom teachers. This is a welcome shift away from projects that "tell" teachers what to teach and how to use technology. Hopefully these projects will have long lasting effects for helping teachers integrate technology into instruction.

By contrast, the papers that deal with undergraduate education do not explicitly discuss whether that instruction might be more effective if teams of undergraduates worked together. We need to examine the discontinuity of approaches in undergraduate education with approaches

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used with K-12 teachers. If we continue to deal with preservice and inservice teachers differently, then there will continue to be a mentality of developing inservice programs that "fix" inservice teachers by providing education on "new" ideas. Wouldn't it make more sense to use instructional approaches in undergraduate education that will transfer to K-12 education? Then teachers might not find the transition from being a university student to being a teacher so difficult.

But this argument probably ought to be extended. If instruction from grades K through inservice education were consistent in philosophy, wouldn't students and teachers all have an easier time of it? If inservice teachers need to work together to change the ways they think about their own learning (e.g., learning new pedagogy), shouldn't preservice teachers do the same (e.g., learning content, pedagogy, and child development)? And if undergraduates should work together, shouldn't high school students? And if high school students should work together, shouldn't middle and elementary school students? We know that change is a difficult and lengthy process, so if we conceptualize all learning as change, then the types of support needed to foster change would seem to be conceptually similar across all kinds and levels of learners. In particular, learning how to learn with technology might be easier if learners at every grade level worked together and shared their developing expertise.

Integration of Content and Technology

It is noteworthy that the reports in this section highlight the importance of making connections among content and between technology and content. Sometimes the connections were "enforced" because of the make-up of teams of teachers accepted into inservice projects, and sometimes the connections came naturally from the way a project was focused. Both mathematics education and science education groups at the national level are calling for more connection (and less isolation) of content, so the reports here may simply reflect current trends in the disciplines. However, I hope that when these reports are presented at the 1993 STATE meeting, they will spark extensive discussion of the benefits and the drawbacks of emphasizing connections among content. More projects in which connections are highlighted will need to be analyzed and reported before we know how that approach affects the quality of technology-based instruction provided not only *for* teachers but also *by* teachers.

None of the projects this year suggest the teaching of technology for its own sake. Rather, technology is tied to specific mathematics and science content. Unfortunately, the papers are uniformly weak in their descriptions of the specifics of how technology was used to enhance either teachers' understanding of content or teachers' delivery of instruction about that content. My hunch is that we will find over the next few years that teaching connections between technology and content is a very complex activity. In order to understand that complexity, we need to have rather complete descriptions of the instruction provided for teachers. We need to develop techniques for describing the important details about instruction, so that readers can relate instructional techniques across projects. Perhaps reports in future year's *Annual* can experiment with different ways of detailing their instructional approaches, so that over a long period we can develop some conventions about how to provide the necessary detail.

Citation of Evidence

The biggest disappointment in reading the papers this year is the "softness" of evidence presented in support of the conclusions and generalizations. Clearly, part of the explanation for this is the limitation on length for articles in the *Annual*. No doubt the evidence does exist; it simply couldn't be reported in detail within the limitations of this publication outlet. However, I do suggest that, in the future, more of the evidence needs to be presented, even in papers as short as these.

For quantitative studies, there are numerous conventions among educational researchers about what kind of evidence is adequate support for conclusions and generalizations. However, for evaluation studies and qualitative research, we all seem to be struggling with the development of acceptable criteria for adequacy of evidence. As academicians, we must demand high standards of evidence both of others and of ourselves. We need to know what claims are real, and it is only through examination of the evidence that we can be convinced. As users of technology, we must demand convincing evidence in support of claims about the effects of technology use. Evidence gives us the confidence to act on the claims and alter our own uses of technology in teaching and in teacher education.

It is interesting to me that most authors point to "research evidence" as part of establishing their theoretical frameworks. Yet, the "evidence" presented by these same authors in support of their conclusions is too often only the stating of those conclusions. How will future researchers use these papers in developing more sophisticated theoretical frameworks? Will the statements of conclusions and generalizations be cited as the evidence? I think we would be on safer ground if authors provided clear research evidence along with the conclusions and generalizations. Then future researchers would be better able to weave research studies into a coherent whole.

In Closing

The progress we have made in designing and studying ways that we approach technology teacher education in mathematics and science reminds me somewhat of the progress we have made in the study of problem solving. There is now a much better balance between teaching about technology (or problems solving) in isolation and teaching about technology (or problem solving) along with the study of content. There is a much better balance between asking individuals to master technology (or problem solving) alone and asking learners to share their developing understandings about technology (or problem solving) with other learners as they are collectively involved in the process of learning. There is also a recognized need for research and evaluation about technology (or problem solving) to be set within clearly articulated theoretical frameworks. These progressions are all for the good. Success at integrating technology into mathematics and science teaching depends on our developing a healthy respect for the complexity of the processes involved and a rich base of evidence that will guide our practice. As technology changes and becomes more powerful and more sophisticated, the challenges for thorough integration into instruction will become even greater. We will need exponentially more information about the effects of technology in order to use new technology effectively. The shifts in knowledge reflected by the reports in this section represent steps in the right direction.

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A constructivist use of technology in elementary mathematics

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Mathematical Constructivism and Technology

There is currently a negative view toward the use of technology on the part of many practicing mathematics educators and instructors of mathematics methods. This exists for a wide variety of reasons including the history of the computer as an instrument of "drill and kill" in the area of mathematics, emphasis on computer-based units that seem to emphasize procedures over problem solving, and the lack of student-centered construction of meaning evidenced in many programs. This is a sad state of affairs, for technology has the potential of advancing the very goals of the NCTM (1989) which mathematics educators point to when they bemoan the use of technology in mathematics instruction.

In an attempt to address concerns such as these, a series of longitudinal collaborative research projects have been conducted between university personnel and four local elementary schools. In these projects a significantly different perspective—with technology at its center—was taken in specifying curriculum, instructional focus, and evaluation methods.

Curriculum Focus

The curriculum used in these projects was conceptually based and utilized a five-phase approach which allowed students to construct mathematical intuition via physical materials (Peck & Connell, 1991). In this approach, the initial two phases made use of physical materials in a much different fashion from traditional approaches. Rather than using manipulatives to demonstrate procedures or rules, problems were posed which required active student involvement with physical materials to model mathematical situations, define symbols, and develop solution strategies via actions with the materials. As the children used these physical materials to solve problems, they actively constructed operations and principles of arithmetic. The third phase required students to sketch the physical materials and situations experienced as a means of encouraging a move toward abstraction. The sketches then served as the basis for additional problems and as tools for thinking. In the fourth phase, the children constructed mental images through imagining actions on physical materials. The experiences with mental images provided a basis for the fifth phase where students constructed strong arithmetic generalizations and problem solving skills.

The computer in this project was just another "tool" available to the students in their ongoing efforts to construct meaningful methods of dealing with the problems they encountered. The nature of this tool, which was provided for students to "think with," came to shape their performance and cognitive styles. When a computer was available for students' use, the problem solving situation shifted toward the identification and selection of what data to include in the problem, identification of the problem goals, and choosing appropriate procedures and control statements to use to obtain and verify the desired results. As a consequence of this instructional sequence, the children constructed a series of related mathematical concepts. When these concepts and applications were over-learned the students instructed a Macintosh via HyperTalk to carry out the necessary instructions and operations which they had derived.

It must be noted that although the computer played a pivotal role in each of these projects, it is a much different role than that usually associated with computer assisted instruction. Rather than using the computer for its incredible speed, the computer's infinite patience and need for exactness of logic and clarity of expression was utilized. Such use of the computer allowed individual students to use a variety of techniques and representations as a means of sharing their developed knowledge and expertise effectively. The computer assumed the role of an active listener that would do exactly what it was told, as opposed to a pre-programmed instructor requiring a specific type of answer.

Throughout each project, a major goal of the curriculum was to enable the successive internalization and abstraction of the preliminary physical experiences the children shared. Each of the outlined phases was viewed as a step along the path toward eventual mathematical abstraction. For example, the sketches drew much of their power from earlier experiences with objects. In a similar fashion, the mental images reflected the sketches and manipulations performed by the students. The interrelated nature of these experiences set the stage for abstractions and the intuitive foundation upon which the abstractions could safely rest. These abstractions, rather than being based upon a single demonstration of rules, rested upon a tightly woven network of understandings.

Instructional focus

An explicit instructional objective was to help each child find a way to answer the question, "How can you tell for yourself?" for all portions of the mathematics they were learning. The instructors shared the common belief that children must be allowed to figure things out and be responsible to themselves, not a teacher or answer key, for their results. It was felt that if children are to engage in thinking about and solving problems for themselves, then they must have a "place" to go in order to be able to determine if they are making sense. Physical objects in this instructional model served this purpose. These beliefs, coupled with the earlier described curriculum focus, led to the following principles (Peck, Jencks, & Connell, 1989):

1. The instructor did not explain. The instructor served as a problem poser, skeptic, and question asker focusing upon *student* explanations.
2. Manipulations with physical materials defined meanings which were associated with arithmetic symbols and operations. Problems were developed requiring an appeal to those objects and meanings.
3. The instructor attempted to enable the children to internalize and abstract their experiences by requiring them to work problems in the absence of the physical materials.
4. The instructor used a meaning-centered evaluation scheme.

Evaluation Focus

Evaluation schemes used in traditional instruction often appear designed to identify and reward "winners" over "losers," using information acquired from measures of success or failure on narrowly prescribed sets of cognitive tasks (Corrigan, 1990). In an approach such as the one utilized in the studies reported here, in which every child is to be given the chance to construct the necessary understandings to be a winner, this approach seemed tremendously wasteful of human potential.

A two-step evaluation scheme was used to guide classroom instruction. It involved the use of Sato's Student-Problem Chart (Sato, 1990, Switzer & Connell, 1990) and a follow-up teacher interview (Peck, Jencks, & Connell, 1989). Each of these techniques is quite effective alone, but when used together they have been found to provide a very efficient methodology in assessing students' understandings. The information provided in Sato's reporting format allowed the teachers to identify quickly both problems and students with unusual patterns of responses - indicating potential sources of difficulty and identifying key questions to ask selected students. This approach enabled teachers to determine whom to talk to and what questions to ask to maximize effectiveness in the interview itself. Student interviews were then conducted to evaluate student explanations and problems. These follow-up interviews with key students and problems provided for meaningful feedback on the results of instruction and on any non-productive conceptualizations that may have been constructed. In short, this was a closer examination of what the students were *thinking* and not just what they were *doing*.

Findings

As might be expected, the data gathered over the course of these studies included a wide variety of measures. Although other data were gathered, the discussion will focus upon two primary strands of evidence, one quantitative and one qualitative. Discussion of the first strand will consist of a series of analyses performed on the pretest and posttest data collected during the project's first year. The second strand will consist of extracts from the taped interviews and student notebooks collected during the first and second year. The mixed methodology discussed in the previous section was carried out throughout these studies as a means of guiding the instructional focus.

Quantitative Findings

A mathematics inventory developed by the author was used to gather student pre and post data. This assessment had been used in earlier studies by the author and mapped nicely to the curriculum of the school. For this study, validity controls were constrained to face and content validity as determined by the teachers and investigators taking part in the study. It should be noted that an earlier extensive cooperative effort with a district-level evaluation team (from another state) had been undertaken in which extensive item analysis was performed to select the best items and establish the item-to-objective mapping used in this study. Reliability estimates using Cronbach's alpha were calculated for both pretest (alpha = .74) and posttest (alpha = .84) versions of the inventory.

An initial examination of the pre and post total scores showed that growth was indeed made during the course of the year ($t = 7.93$, $p < .001$). Although heartening, this finding must be tempered with the realization that this intervention took place over the course of a year. Had a significant difference *not* been found it would have been cause for great alarm on the part of the investigators, not to mention the local school authorities. In looking at the content areas measured, and in light of the instructional focus of the year, several increases worthy of notice were observed. Although geometry and statistics were not formally presented during the year these scores increased. It was in the areas of extended mathematics (pre-algebra) problems, miscellaneous problems (which required a variety of problem solving strategies), and estimation (which although not formally discussed was inherent in all student work) that the greatest increases in student performance were observed. A near doubling in student performance in each of these areas provides strong evidence that the instructional emphasis upon student problem solving was effective for this group.

An additional support for this may be found in examining the Modified Caution Signs computed for the students using the pre and post assessment. This index may be interpreted in the following manner: an A type response indicates high levels of performance and consistent patterns of item response, B indicates high performance and inconsistent responses, C indicates low levels of performance and consistent responses, while D represents low performance and inconsistent patterns of response. The number of students identified as having type A responses nearly trebled over the course of the intervention while the number of students having type B increased. This was accompanied by a corresponding decrease in the number of students showing C and D response patterns.

Qualitative Findings

The reported findings derive from interviews conducted throughout the interventions and from the student notebooks in which the students wrote five minute reflections of their work at the end of each session. A major observation from the student interviews lay in students' perceptions of problems and the associated problem solving efforts which they attempted. In particular, there was a consistent "reversion to form" on the part of the students. As long as the problems made sole use of newly constructed information the students were able to utilize their developed understandings. They were able to demonstrate effective problem solving strategies which required both conceptual and procedural understandings. This situation shifted dramatically, however, whenever prior knowledge was required as part of the problem solving efforts.

This reversion to an earlier, simpler, and for the most part inaccurate level of functioning occurred most often whenever time pressures came into play (such as those associated with a test) or an over-learned piece of prior procedural knowledge was involved in dealing with the problem situation. The strength and persistence of this observation suggest that great caution be taken regarding the nature of the initial mathematical experiences provided to children.

In examining student's notebooks, several observations seem in order. First, in almost every case there was a marked increase on the part of the student toward self-posed problems as opposed to teacher directed problems. This shift took place at different times for different students, but was nearly uniform throughout the class. These self-posed problems came to be a driving force in the instruction and a source of student pride as evidenced by the student notebooks. The appearance of a substitute, as evidenced in many notebooks, was a trying event for the children. Many of them dealt with this by doing it "the old way" on paper and then "talking about it" with their friends. Others merely "did it (the problems) the old way" and then complained about having to do worksheets. Time became a problem, not because of the time necessary for conceptual development, but because time would run out. The children's enthusiasm was evidenced by such comments as "It was time to go but I had to try it one more time so I could see for sure it worked" which was echoed in many places in the notebooks.

Students could be observed to be actively engaged in solving their own problems based upon group constructed meanings and procedures. The motivation came from the problem situation itself and the computer was viewed as a tool that was used to verify independently achieved results, not to dictate instruction. The result was a marked shift toward successful independent problem solving as indicated by the quantitative analysis and borne out by interviews and observations.

Implications and Summary

This program of research has many implications for helping educators address some of the burning issues facing mathematics education. The conceptual frame used in this set of endeavors appears to provide the means for a continuing and deepening awareness that understanding is more than an iterative procedure done without personal meaning. The author is reminded that many of the fractals, commonly described in chaos theory, are generated in just this fashion - an iterative procedure, done thousands of times without meaning in and of itself - leading to chaos (Gleick, 1987). Understanding in elementary mathematics must involve the active search for, creation of, and use of links between the powerful abstractions and generalizations of mathematics and the world of personal experiences from which they derive their application and utility. Cognitive constructivism provides a valuable set of perceptual lenses through which to look at the problems and potentials of learning in mathematics.

In summary, students typically developed the following characteristics during the course of each intervention:

1. The children had meanings for the symbols that guided their thinking.
2. The students were active as opposed to passive in their attempts to learn.
3. The students developed rules as conveniences, not as binding procedures.
4. The students had confidence in their own thinking and could decide whether they were making sense.
5. The students were able to readily make interpretations and work toward solving unfamiliar problems.

These outcomes seem more in line with the type of mathematical thinking and problem solving abilities required of the upcoming generation as widely expressed by NCTM (1989). The key elements in moving these children toward these higher level goals appear to have been the use of physical materials which embody mathematical situations, posing problems about the materials, helping the students internalize their experiences, the use of the computer as a tool for the expression and communication of their developing understandings, and gently but firmly insisting that the children use the materials to make their own decisions.

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Computers in science: A school-based training program for applying technology to the elementary science curriculum

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American schools, most people would agree, are in deep trouble. The National Governors' Association (1991) cites some alarming statistics:

1. High school achievement is lower now than when the Soviets launched Sputnik 34 years ago.
2. Science achievement scores have been declining for 30 years.
3. One-fourth of all mathematics taught in public colleges is remedial.
4. In international tests of student achievement, Americans never scored first.

These trends appear across the country and show that the average citizen is becoming less intellectually capable: less each year and less through generations. This continuing decline puts the very foundation of American democracy at risk.

There are many opinions and ideas about how to solve this crisis in American education. Ideas come from every sector of American society - the federal government, private corporations and foundations, researchers, and leaders in education. Most experts and policy makers agree that students should become more literate in science and technology, and schools should become more accountable.

Maryland's schools reflect the national trends, and the state's response to this crisis has been swift and effective. In 1987, fully two years before the President's education summit, Maryland's governor established the Commission on School Performance to study education throughout the state and identify needed reforms. As a result of this work, the State Department of Education created the Maryland School Performance Program (MSPP) which includes definitions of learning outcomes for students in areas of reading, writing, mathematics, and science.

In the area of science, the MSPP seeks to define learning outcomes that prepare youngsters for the information age. The MSPP challenges students to (a) demonstrate the acquisition and integration of concepts, (b) interpret and explain information, and (c) apply scientific thinking and reasoning in making personal decisions about issues affecting the individual, society, and the environment. The major concepts and unifying themes revolve around life, physical, earth, and space sciences. The learning outcomes are measured by performances which demonstrate the thinking and acting inherent in the practice of science and its relevance to decision-making responsibilities as citizens of a global community.

Baltimore City mirrors the national and state crisis in science and technology education. Baltimore is meeting the challenge by preparing students to be sciences employees of the future. As part of its commitment to provide the best science, mathematics, and technology education, the Baltimore City Public Schools (BCPS) has developed Science: Thinking, Application, and Research Skills (STARS), a curriculum designed to be implemented in conjunction with school restructuring. This curriculum development project, funded by the National Science Foundation, includes leadership training for educators who are interested in becoming hands-on science "lead teachers" in their schools.

Federal Hill Elementary School completed the initial steps for restructuring to be a model science-technology school. It adopted the STARS hands-on science curriculum, identified lead teachers, included special needs students in the curriculum, and acquired basic hardware and software. Subsequent training ensured the implementation of technology in the classroom as an integral instructional tool.

The purpose of this project was to provide training for faculty and staff of one BCPS elementary school in the use of technology in order to implement the existing hands-on science curriculum across the disciplines with all students. The training outcomes were (a) the teachers' expanded knowledge of elementary life, chemistry, physics, and earth science concepts, (b) implementation of model lessons that integrated technology with the STARS science units by using elementary level tool software (i.e., word processing, graphics, desktop publishing, database, and spreadsheets), commercial interfacing devices, on-line electronic databases, and CD-ROM resource materials, (c) inclusion of students with special needs in the full range of science activities, (d) development of performance-based assessments for monitoring student progress, and (e) adequate preparation for teachers so they can support and coach other BCPS elementary teachers.

Methods

The training used the resident computer equipment (a distributed network with 45 IBM work stations placed throughout the instructional areas) and software and commercial interfacing devices applicable to the STARS curriculum materials. The entire staff - ten regular (including "lead") science teachers, two special education teachers, one resource teacher, the principal and one instructional aide serving as computer coordinator - participated in the training program. The year-long training included twelve weekly sessions through the spring, five consecutive days during the summer, and ten weekly sessions in the fall. The training sequence consisted of instruction in a particular technology tool and ways that tool could be used to implement a particular science unit across the other disciplines, development of model lessons with adaptations for special needs students, development of performance assessment items, practice with the technology and applications in instruction, and feedback for revision and refinement of lessons. Training sessions were led by the project coordinator assisted by an education instructional specialist consultant from IBM. Frequent site visits between sessions were made to support implementation.

Assessment Procedures

Two Concerns-based Adoption Model (CBAM) assessment dimensions, Stages of Concern (SoC) and Levels of Use (LoU), were used to measure the innovation defined as the integration of technology in the STARS science curriculum and across the curriculum. The SoC questionnaire addresses (a) how individuals perceive an innovation and (b) the concerns that they have about the effects of implementing it (Hall, George, & Rutherford, 1979). It is a standard 35-item questionnaire which addresses seven types of concerns that individuals experience as they implement new programs. These range from early concerns about "self," to concerns about "tasks," and finally to concerns about "impact."

The LoU Interview reflects the performance changes as the individual becomes more familiar with an innovation and more skillful in using it (Hall, Loucks, Rutherford, & Newlove, 1975). The LoU focuses on whether or not the educator is using an innovation and, if so, the level of implementation. Typically an individual begins with LoU 0 ("non-use" of the innovation), then moves to LoU I ("orientation" about the innovation) and LoU II ("preparation" for use of the innovation). Initial use at LoU III is "mechanical," but as experience increases, innovation users progress to LoU IVA ("routine" level of use) and eventually may reach various "refinement" levels designated as LoU IVB, V, and VI, where changes are made based on formal and informal assessments of student needs. These eight distinct LoU are descriptions of a user's behavior rather than attitudinal or motivational aspects of a user's implementation.

Results

The results for pre-training assessment will be presented and indications of change after training will be described. Twelve staff completed the SoC questionnaire in March, 1992. Two teachers had concerns at the Awareness stage indicating little concern or involvement with the innovation. Ten teachers had intense concerns at the Informational and Personal stages. These participants indicated a general awareness of the innovation and an interest in receiving more information about the requirements, general characteristics, and effects. However, there was great concern about the expectations and personal demands that would be incurred.

Participants completed the second administration of the SoC in November, 1992, following the series of training sessions. Initial analysis indicates that concerns are becoming more intense at the Management and Consequence stages. Those teachers reflecting management concerns are focusing on efficiency, organization, and scheduling issues relevant to implementation of the innovation as presented in the training. The Consequence stage implies a concern for the effects of the innovation on the students and their performance outcomes.

The LoU interview was also administered to the staff in March, 1992. All but one teacher reported activities indicative of the Preparation (II) level. They were engaged in learning about the innovation and the requirements for use and were preparing to begin as soon as the necessary equipment was installed in their classrooms. One teacher was less involved in preparation for beginning implementing the innovation but was interested in Orientation (I) activities for finding additional information about the innovation.

The second administration of the LoU questionnaire was conducted in November, 1992. Preliminary analysis indicates that ten teachers are now actively implementing the innovation at Level III, the Mechanical Use level. Although using technology regularly, they are consumed with organizational issues revolving around grouping students, scheduling activities, and relating the technology to the curriculum. Lack of preparation time is reported as the major barrier to implementation of the innovation as routine procedure in instruction. The two teachers not yet at Level III are at the Preparation Level II. A delay in installation of the equipment in their instructional areas have impaired their implementation efforts.

Conclusions

The developers of the CBAM model contend that innovation adopters' concerns change in a logical and predictable progression as users become increasingly skilled in using an innovation (Hall & Hord, 1987). They further suggest that the LoU defines steps in growth toward sophisticated use of an innovation. To facilitate growth of implementors and increase use of an innovation, strategies must be developed. The progress toward innovation adoption in this project indicates that the on-site training model is employing effective strategies for facilitating change in instruction in this elementary school.

Products for the training include teacher-developed lessons to be used with the STARS curriculum. Approximately 25 lessons with computer activities have been produced. Teachers are referring to these lessons in their instructional plans as well as sharing their plans with other teachers at the same grade level. They have also designed four thematic units which incorporate science topics across the curriculum with applications for technology in all the activities. Most activities are planned for cooperative learning groups which include students with special needs. The special education teachers collaborate with the lead science teachers in planning instruction.

Finally, a science-technology conference, open to the parents, school board, and community partners, was held in October, 1992, to demonstrate the science/technology activities. Students demonstrated computer applications for model science and mathematics lessons at each work station, the CD-ROM learning station, and the Personal Science Laboratory. Reports generated on the word processor and illustrated by the graphics programs were displayed on bulletin boards. Students representing each class described their involvement with computers in the classroom. Several special education students participated in the demonstrations, displays, and presentations. As the guests observed in each class, the teachers explained their strategies for implementing science/technology instruction with computers.

The training model included strategies not only for delivery of information but also for development of materials and activities that required the participants to become facile with the innovation. Teachers were actively engaged in identifying the concepts pertinent to their own teaching assignments. Opportunities for immediate applications facilitated the development of competency with the technology and utilization in instruction. The assessment procedures confirmed that as the staff gained experience with the innovation, their personal concerns dissipated and their level of use progressed toward routine implementation.

Continued training will support the progression of adoption, particularly as it affects students. Future training will include strategies for assessing student performance and for collaborating with other teachers regarding the innovation. The impact on students will be assessed by changes in attendance, achievement scores, and parental involvement. Opportunity for collaboration will be facilitated by extension of the training to staff of four other elementary BCPS schools. The staff will serve as peer coaches to new trainees; the building will serve as the model site for the innovation. The effects of training with peer coaching will provide direction for planning future staff development activities for implementing technology in science and across the curriculum.

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Using technology in scientific applications of mathematics at the middle school

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Project Objectives

The objective of the project is to create and implement integrated middle school mathematics/science units, using microcomputer technology. The same students will be learning mathematics concepts and science concepts from the same units. Teachers and students will see and emphasize the integration of mathematics and science.

Course Format

The workshop is conducted as a one-week residential program. The course is designed around a school building team model, which provides the following advantages:

1. Opportunities for cooperative learning and individual accountability
2. Continuous planning which increases the potential for curriculum and instructional changes to occur following the course
3. A support system for individuals as they implement change

The participant teams were one science teacher and one mathematics teacher from the same grade level and building. It is possible that some teams may have a third member, the technology teacher from the same middle school.

Course Content

The course is an experiential workshop format. The workshop's focus is on flight. This topic was chosen for several reasons. First, the middle level curriculum contains the study of physical science and earth science. Second, the topic is rich in ideas that may be used in science and mathematics. Third, the intrinsic motivation of the concepts attract and hold the interest of the middle level learner. Fourth, the topic provides a wide variety of "hands-on" activities that are appropriate for the middle school.

The course addresses the general goals for students as proposed by NCTM (1989). These goals for students are (a) that they learn to value mathematics, (b) that they become confident in their ability to do mathematics, (c) that they become mathematical problem solvers, (d) that they learn to communicate mathematically, and (e) that they learn to reason mathematically. These goals imply that students need to be involved with well designed, success-oriented experiences that will help them develop their mathematical expertise. Special attention is paid to the report of Project 2061 indicating the importance of the scientific process; that is, investigative question, experimentation, data collection, analysis, and hypothesis testing.

The course also addresses the characteristics and needs of the middle level student. As changes occur in students' intellectual, psychological, social, and physical developments, they begin to develop their abilities to think and reason abstractly. However, throughout this time, concrete experiences continue to be the means used to construct knowledge. Teachers participating in the project have an opportunity to study the latest research related to brain growth and cognitive development and to experience the teaching of mathematics and science using technology in a manner which best addresses the needs of the young adolescent. The unit on flight includes the study of concepts related to powered, and non-powered flight, as well as space exploration.

Recent curricula projects are used to achieve the goals. Concepts and materials from Challenge of the Unknown, the Quantitative Literacy project, and the Middle Grades Mathematics Project are used in the unit. All related units from the Teaching Integrated Mathematics and Science (TIMS) project are presented. The presentation and integration of the following appropriate software is included.

Data Insights (Sunburst)
Playing with Science: Motion (Sunburst)
Insights into Science Data (Sunburst)
Discovery! Experiences with Scientific Reasoning (Milliken)
Science Tool Kit Module 1: Motion (Broderbund)
Flight Simulator (MicroSoft)
Paper Airplane Pilot (MECC)
Rocket Simulator (Estes)
Interactive Physics (Wings)

Involving local scientists in a school's instructional program is modeled with presentations by field personnel from the Experimental Aircraft Association (EAA)—a hang glider enthusiast, a pilot, and a meteorologist. Participant teams are assisted in the process of making similar connections in their community. Throughout the unit, the fundamentals of scientific inquiry are presented; that is, generate data, collect data, analyze data, and draw conclusions.

Course Content Outline

I. Orientation
  A. Pretest
  B. Physical, emotional, and cognitive development of middle level learners
  C. Discussion of Project 2061 and NCTM (1989)
  D. Concepts of integrated curricula
  E. Cooperative learning
II. Flight
  A. Kites, Planes, Gliders, Water Rockets, Estes Rockets
  B. Rubber Band Trajectory unit
  C. Clinometer use and construction
  D. NASA Bulletin Board System (BBS)
III. Integrated Teaching
  A. Science, mathematics, technology goals
  B. Mutual planning
  C. Administrative and parental understanding and support

Day-by-Day Plan

Monday
  AM Flight Unit Video Introduction
    Construct Estes Model Rocket
    Rubber Band Cannons
    Clinometers
  PM Water Rockets (build, launch, collect data, mathematics connections, and analysis)
    Bottle Launcher
  Eve Data analysis - Data Insights
    Computer software review
Tuesday
  AM Paper Airplanes (build, launch, collect data, mathematics connections, and analysis)
    Rubber Band Airplanes (build, launch, collect data, mathematics connections, and analysis)
  PM Plastic Battery Powered Airplanes (build, launch, collect data, mathematics connections, and analysis)
    Launch Estes Rockets
  Eve Software
    Factors & Multiples
Wednesday
  AM Kites (TIMS)
    Tetrahedral Kites (build, launch, collect data, mathematics connections, and analysis)
  PM Challenge of the Unknown (review materials)
  Eve Unit planning and writing
Thursday
  AM Field trip to EAA
  PM Field trip EAA/Airport/Control Tower/Hang Gliding Demo
  Eve Student Assessment Procedures
    NASA BBS
Friday
  AM Flight Fair Competitions
    Paper Airplanes
    Kites
    Water Rockets
  PM Flight Fair Competitions
    Rubber Band Cannons
    Rubber Band Airplanes
    Estes Rockets
    Water Rockets
    Bottle Launcher
    Flight Fair Awards

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Introductory calculator inservice for middle school mathematics teachers

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In North Carolina, there is an announced state policy that beginning in spring 1993, students in grades 6-8 will be required to use fraction calculators on end-of-year tests in mathematics. Approximately 15% of the items will be completed without use of a calculator, but the remaining 85% will be written with the assumption that students have calculators available to use. This requirement has caught most school districts and almost all teachers by surprise; there has been little planning to provide inservice for teachers on appropriate and effective ways to use calculators in instruction. Yet, if students are going to be successful on these new tests, calculators need to be used regularly and systematically during normal instruction. Teachers undoubtedly need some assistance in learning how to use calculators in instruction to increase conceptual understanding of mathematics.

A distinction should be made between "instruction allowing calculators" and "instruction supplemented by calculators." When teachers provide instruction allowing calculators, students are given traditional lessons and may choose whether to use calculators. When teachers provide instruction supplemented by calculators, the power of the calculator becomes an integral part of instruction. Calculators are used to enhance understanding of mathematical concepts as well as to support rapid computing.

Calculator Inservice Project

This inservice was part of a three-year project designed to help middle school teachers learn to teach mathematics supplemented by fraction, scientific, and graphing calculators. Participants were 23 middle school teachers (22 female, 1 male) selected from among teachers who applied to the project. The teachers were from central North Carolina; minimum teaching experience was three years at the middle school level. As part of the application, each teacher had to obtain district support for (a) access to classroom sets of calculators and (b) release time to attend follow-up meetings during succeeding academic years.

During the first semester of the project (Spring 1992), teachers participated in a series of four Saturday workshops designed to introduce the capabilities of the three calculators. Original plans called for one workshop on the fraction calculator, one on the scientific calculator, and two on the graphing calculator. However, the pace of the workshops had to be slowed, resulting in about equal amounts of time devoted to each of the calculators. During this semester, the project's advisory committee suggested that since the graphing calculator would be heavily used during a summer course on functions, time devoted to that calculator during the spring workshops could be decreased.

Workshop activities were designed to be similar to activities appropriate for middle school students, though no attempt was made to restrict the language of the activities to be at the level of middle school students. Rather, the activities were designed for adult learners. Sources of activities included Bright, Usnick, and Lamphere (1989), Kenelly and Harvey (1992), and Williams, Copley, Bright, and Lamphere (undated - a, undated - b).

Teacher Survey Data

At the beginning of this project, a variety of information was gathered, through surveys and individual interviews, to document the teachers' experience with and attitudes toward calculator use in middle school mathematics instruction. This report deals with the initial attitudes and understandings of the participants concerning calculator use in the classroom. It also traces some of the teachers' reactions to the information and materials presented in the four Saturday sessions.

Like most other teachers in the state, the project teachers began this project with very little experience using calculators in mathematics instruction. The fact that the teachers were willing to apply for the project and commit three summers of their time to take graduate courses suggests that they may have been more concerned about calculator use than other teachers and more open to the use of calculators in normal instruction. Nonetheless, the initial data on the project participants reveal something of the "prevailing condition" of middle school mathematics teachers.

One question asked teachers to rate their knowledge, experience, and confidence about the use of four types of calculators (Table 1). A five-point scale was used: 1 (low) to 5 (high). As expected, the teachers had the most experience with four-function calculators and the least experience with graphing calculators. However, the greater experience with fraction calculators as opposed to scientific calculators was somewhat of a surprise, since scientific calculators have been more widely available than fraction calculators. When teachers were asked in the interviews which calculators (other than four-function) they had used, 12 mentioned fraction calculators, 8 mentioned scientific calculators, 4 mentioned graphing calculators, and 5 said they had no experience. Six teachers listed two types of calculators, but no teacher mentioned all three types.

Further, teachers were asked to list the three most important concerns about the use of calculators in instruction for four groups: themselves, other teachers, principals, and parents. The most frequent responses are given in Table 2. (Since each teacher listed three concerns it was possible for counts to exceed 23.) One surprise was their perceptions of the concerns of school principals.

Workshop Evaluations

Workshop evaluations were positive, but several items specifically addressed opinions of teachers relative to their perceptions of the information presented, appropriateness of activities, and aspects of calculator use in

Table 1
Teachers' Mean Ratings of Knowledge, Experience, and Confidence

Type of Calculator	Knowledge	Experience	Confidence
Four-function	3.8	4.1	3.5
Fraction	2.6	2.6	2.7
Scientific	2.2	2.3	2.4
Graphing	1.7	1.6	1.8

Table 2
Number of Times Concerns Were Listed about Calculators in Instruction

Concern	Personal	Other Teachers	Principals	Parents
Cost/availability	21	19	27	17
Student dependence/Loss of basic skills	17	11	3	23
Time in the curriculum	7	3	4	0
Testing	3	2	3	2
Teacher qualifications/teacher education	4	8	8	1

Table 3
Workshop Evaluations

Item	Workshop One	Workshop Two	Workshop Three	Workshop Four
Session contained too much information	2.2	3.2	3.3	2.6
Handouts were worthwhile	4.9	4.3	4.3	4.2
Calculator use is important in instruction	4.6	4.6	4.7	4.6
I don't yet see ways to use calculators in my own teaching	1.2	1.8	1.5	1.2

instruction. Again, a 5-point scale was used (Table 3). The differences for the first workshop may reflect the greater experience that teachers had with fraction calculators.

Participant Interviews

The project staff interviewed each participant; interviews were tape recorded and transcribed. Each interview explored a number of issues related to the use of calculators in instruction. Examination of the interviews revealed three main themes: (a) learning basic computational skills, (b) management of calculators in the classroom, and (c) calculator use and mathematical thinking. Toward the end of each interview, participants were specifically asked what barriers prevented them from using calculators in instruction and whether calculator use would help or hinder students' learning of mathematics. (Throughout the paper, indented material is quoted directly from transcripts of the teacher interviews.)

Basic Skills

Participants shared the expectation that their students must learn "basic skills." In fact, each of the 23 teachers said somewhere in the interview that students need to be able to do computations without any calculator, though they had only vague notions of the specific types of computations that they wanted students to be able to do. Further, participants shared a concern that calculators would interfere with learning basic computational skills. This concern was revealed in several types of comments, which are paraphrased below.

1. There need to be limits on when calculators are available for use. When students are demonstrating their mastery of basic skills (on tests, homework, or class work), calculators should not be allowed. (Of the 23 teachers, 17 agreed that calculator use would be appropriate on non-computation portions of tests, 4 said that calculators should be universally banned from tests, and 2 said that calculators should be universally available. In contrast, the teachers were much more willing to allow use of calculators on homework.)
2. Skills need to be learned before calculators are given to students to use. I want to be sure students can carry out a process before calculators are used. Even if calculators are used, students need to explain and record the process involved. Calculators should be used mainly for checking work that students have already done on paper.

> I used them [fraction calculators] with my students. And to tell you the truth, they were so tickled with the calculator, they didn't want to do it themselves. They wanted that calculator, and it was hard for me to teach them the old way after they had seen this calculator that could do it for them. So I think next year what I'll try to do is make sure they can do it for themselves first.

3. I am concerned that students will become dependent on calculators. If the batteries "die," students need to be able to do computation by hand.

Sometimes students will rely on a calculator immediately for a lot of things that they could do quick or mentally.

> They [students] might not always have a calculator and I think it's necessary that they need to be able to do these things by hand without the calculator. ... The problem I'm having ... is knowing when to let them use the calculators. ... I'm the type of person that likes to know that they know how to do it without having a calculator there. If the calculator is not going to be there are they going to be able to do it? Therefore, I like to see all steps worked out. ... After a while, I'll let students skip steps and take shortcuts which the calculator will do, but I don't like it done right off.

Management

There were several components of the concern about management of calculators in the classroom.

1. Would calculators be available for all students to use?

2. Would only one type of calculator be available in the class?
3. How would teachers distribute and collect calculators in each period?
4. Who is responsible for breakage and theft?
5. Would students tend to damage or steal the calculators?
6. Would the school replace broken or lost calculators?

Teachers seemed most concerned about equity of access for students. A few teachers wondered whether it was fair for some students to have calculators at home while other students did not. None of the teachers, however, indicated that they had given any thought to finding ways to structure homework assignments to overcome the possible inequities of availability of calculators. Too, some teachers recognized that it might be difficult to teach if students were using different types of calculators in class, especially for scientific or graphing calculators. Finally, teachers were concerned about calculator theft and about students' carelessness that might result in damage to calculators. Teachers seemed concerned about maintaining class sets of calculators in working order

Calculators and Thinking

Teachers universally agreed that calculators would change students' thinking. At one level this is related to the concern about loss of basic skills, in the sense that teachers were concerned that students would stop thinking about basic facts. However, 14 of the teachers also mentioned that calculator use would allow students to do problem solving, exploring, patterning, or enrichment. Three teachers suggested that calculator use would give students more confidence to approach mathematics, but none of these three mentioned that calculators would support increased problem solving by students.

Barriers

By far, the most common barrier was availability of calculators, which was mentioned by 10 teachers. Time was also mentioned as a barrier.

> I will probably be the only teacher at my school with a set. ... I don't know how the teachers at my school feel, so I think it would help if there were some sort of training where other teachers would feel that calculator use was okay. ... There's still a lot of teachers, I think that think no it's not a good idea. ... They want to know why I'm using them and how is it helpful. But they don't say "Well I don't think you should." I think they're interested in learning more about them. ... In our network ... one of the topics that teachers really wanted more information about was calculators and computer use in the classroom.

> We have objective based teaching and we have an X amount of objectives that we have to cover and that we have to test and that students have to pass the test without a calculator. ... We're responsible and accountable for that and I find it very difficult to get those objectives taught and find time to use the calculator, even to reinforce. They're so packed with objectives, so many that we have to cover, that is like very minimum amount of time that we have to get it done and to get it covered.

Calculators: Help or Hindrance?

All 23 teachers indicated that calculators would, at least in some circumstances, be a help to students as they learned mathematics.

> I think they're very helpful ... especially ... the [fraction] calculator. ...You see the relationships between fractions and decimals and percents. ... I think a lot of my students in past year have never understood [those relationships].

> A lot of times kids make silly errors because they're under pressure to do it right or they forget to add every grouping number or they group incorrectly because they're rushing. There's just a lot of careless errors. And I think with the calculator— if you're teaching the child that the calculator is there to get a sensible answer and to let them remember that the calculator's there to help them, but they still have to think logically, then it can assist them.

> Well I think they can be a help and a hindrance. I've had students who would tell me well the calculator says this is the answer, so this must be the right answer. And not realizing that they could have hit the wrong keys. They could have entered something wrong. Just because the calculator says 12 does not convince me that the answer is 12.

> I think they [calculators] help. I think for the advanced student who catches onto things very quickly, I think they get very bored doing rote type stuff. They've already learned the concept and the calculator enables them to just go on with it, go further. For the lower students I think I have found that if I had them work it out by hand first and then give them a calculator and now say okay I want you to check yourself, they gain

> more confidence because they're able to self-check. For that reason I think it really helps a lot. It helps all ranges of students and that's what I like about it.

> I like the way that ... you just punched things in and got your answers and I like the thought questions that come after it. ...You're going to have to work it in a lot, if you do it that way, because ... to give the children that much time are you going to be able to cover all that you need to cover? So you see, if I had enough time I really like ... just plugging the things in, then asking the kids questions about it and getting them to understand what's happened. So I think it could be a help if used correctly.

Conclusions

First, knowledge, experience, and confidence about calculator use seem highly related. In part, this is supported by the fact that the order of the averages for the four types of calculators (Table 1) is identical for each of the areas of knowledge, experience, and confidence. Also, the magnitudes of the averages for each type of calculator are similar. We had expected that confidence would be rated lower than knowledge and experience, so this result is surprising.

Second, participants perceived that principals are more concerned with cost/availability of calculators than other groups and less concerned about student dependency on calculators or on loss of basic skills. Given the emphasis in North Carolina on increasing test scores, the second of these perceptions is mildly surprising.

Third, at the start of our project, participants clearly believed that students should be able to perform basic computational skills before calculators are universally allowed. It is interesting that this view is in opposition to recommendations of the National Council of Teachers of Mathematics (NCTM, 1989, 1991). NCTM suggests that calculators should be available during instruction that leads to mastery of basic skills. Workshop leaders need to acknowledge this discrepancy and to help teachers deal with it.

Fourth, participants believed that calculators would be an asset when students are learning higher level mathematics or problem solving. Most agreed that calculators should be available when lessons involve skills other than basic computational skills. Workshop leaders can use this belief to advantage by providing experiences for teachers which develop both problem solving and "basic" skills simultaneously.

Fifth, participants felt that management of calculators in the classroom would be a major difficulty. This concern should decrease as teachers gain experience; indeed, research based on the Concerns Based Adoption Model (CBAM) seems to support this expectation (e.g., Hall & Hord, 1987). Barriers cited by the teachers are characteristic of CBAM's "management" level. CBAM research consistently shows that teachers are likely to move through this stage into the "impact" stage; that is, the stage in which teachers are concerned about how calculators affect students' learning.

Sixth, participants believed that calculator use will ultimately help students learn mathematics. They believed that calculators may enhance understanding, provided that instruction is designed with that goal in mind. But students should not simply be allowed to use calculators without guidance. Participants believed that calculators must become part of the curriculum and wanted to learn how to use calculators effectively. Workshop leaders can build on these views.

Seventh, participants seemed to get overloaded during the second session on the scientific calculator. This overload may have reflected the fact that participants did not immediately see how this type of calculator could be used in instruction. Workshop leaders need to be aware of the potential for overloading teachers if different kinds of calculators are introduced too quickly in workshops.

Eighth, across the four workshops, the ratings of the handouts decreased. This might be due to the fact that the handouts came from different sources, but it also might be due to the fact that in successive workshops the calculators became more sophisticated and less familiar. Graphing calculators may be so atypical for middle school instruction that middle school teachers have difficulty seeing how those calculators could be used effectively. They might rate the handouts as less worthwhile because they see less direct applicability to their own teaching.

Introductory calculator workshops can help teachers begin to understand how to incorporate calculators into mathematics instruction, though expectations should not be high that teachers can move quickly through stages of concern and implementation. Workshop leaders need to be sensitive not only to where middle school teachers begin the journey of learning how to teach mathematics with calculators but also how far they can travel in a short period of time.

Support for this project was provided by the National Science Foundation (grant no. TPE-9153702). All opinions expressed, however, are those of the authors and do not necessarily reflect the positions of NSF or any other government agency.

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Graphing calculators: Networking strategies for inservice instruction

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Theoretical Background

It has been suggested that educational reform efforts must combine three agendas in order for permanent and meaningful change to occur: learning and teaching, appropriate use of technology, and restructuring of the curriculum (Sheingold, 1991). Planning for change requires articulation of a direction for change as well as an understanding of the change process (Harvey, 1990; Rogers, 1983).

In the fall of 1991, the Casio Corporation donated 1500 Casio OH-7000G overhead graphics calculators and 200 training videos for Oklahoma's middle school mathematics classrooms. Distribution and networking efforts were funded by The Oklahoma State Regents for Higher Education through a Quality Initiative Grant to the University of Oklahoma. Networking strategies were used to meet the agendas for teaching, learning, and the appropriate use of calculators. Strategies for change were consistent with and informed by the vision of mathematics teaching and learning articulated by the National Council of Teachers of Mathematics (NCTM, 1989, 1991).

Changing perceptions about mathematics teaching, learning, and the use of technology require the same kind of paradigm shift necessary for the adoption of new scientific theories. Changes in theory result in changes in how reality is shaped and interpreted as well as how meaning is derived (Kuhn, 1970; Suppe, 1979). Constructivism offers a theoretical framework for understanding change at the organizational as well as individual levels while offering insight into the networking strategies employed by this project.

From a constructivist perspective, change at both the organismic and organizational levels includes the processes of adaptation and self-regulation. At the individual level, changes in conceptual understanding occur as mental structures adapt through the processes of assimilation and accommodation (Piaget, 1970). Social change likewise requires adaptation as the community assimilates or accommodates new or revised organizational or meaning structures. Self-regulation is part of the change process as individuals and organizations reflect upon, monitor, and adjust strategies and behaviors. Cognitive conflict, experimentation, and reflection are essential ingredients for individual as well as organizational change and can be expected throughout the change process. Change results in new meanings and learning, while uncertainty, confusion, and problems are inherent to and necessary for successful change to occur and become permanent (Fullan & Miles, 1992; Suppe, 1979).

Educational reform efforts require the cooperation and leadership of teachers in order for permanent change to occur (Berman & McLaughlin, 1977, 1978). Teachers' knowledge, attitudes, and beliefs have been shown to effect the success of reform efforts (Clark & Peterson, 1986; Fennema & Franke, 1992; Thompson, 1992). While it has been suggested that changes in beliefs precede changes in practice (Richardson, Anders, Tidwell, & Lloyd, 1991), there is some evidence that knowledge, attitudes, beliefs, and practice are more interactive and interdependent than once thought (Franke, Fennema, Carpenter & Ansell, 1992). Negotiation must occur throughout the change process as individuals and the learning community struggle to construct meaning from the changing environment (Vygotsky, 1978) while theories or paradigms adjust in order to establish harmony and eliminate dissonance (Suppe, 1979).

Negotiation in the learning environment is enhanced when networking strategies are employed. Networking provides opportunities for informal and formal organizational arrangements, modeling of materials, personnel and materials support, communication and dissemination of ideas, and the expansion of leadership opportunities. From a constructivist/social learning theoretic perspective, these interventions must maintain fluidity as the learning environment adapts to change and reinterprets meaning. Key to the success of this project was the establishment of a network of education professionals as described below.

Networking as an Alternative to Traditional Inservice

The defining characteristics of networks in the field of electrical engineering include "1. the nature and value of the elements forming the network, such as resistors, inductors, transistors, and so forth, [and] 2. the way these elements are connected together" (Deo, 1974, p. 4). Just as an electrical network or circuit is identified and defined by its parts and the arrangement of those parts, an educational network is defined by its individual components and the relationship among the components. The final production or outcome of any network, whether the components are resistors and capacitors or human beings, is dependent upon and can be predicted from its inherent structure.

Rather than indoctrinating teachers to a particular point of view or methodology, teacher networks provide opportunities for classroom teachers to take leadership roles in the development and sharing of curriculum materials and pedagogical approaches (Lieberman & McLaughlin, 1992; Watts & Castle, 1992). As the teaching-learning community struggles with change, networks provide opportunities for teachers to construct meaning and adapt to change. Traditional inservice attempts fail to consider the potential impact of teachers for affecting change as well as their individual and collective needs to struggle with change. It is no secret that traditional inservice opportunities have limited success in affecting permanent curricular reform (Lieberman & McLaughlin, 1992) largely due to limited empowerment of teachers during the development and implementation of curricular and pedagogic change.

The human components of this project's network included university and state department personnel, educational innovators, early adopters, opinion leaders, latent adopters, and resistors to change. These individuals assumed various roles which contributed to the success of the project. Five strategies were employed which connected these individuals and defined the network.

1. Identify and solicit support from a population of mathematics education innovators, early adopters and opinion leaders.
2. Create a new leadership cohort from among the ranks.
3. Articulate the vision and model materials for the new leaders to disseminate.
4. Employ rapid dissemination strategies.
5. Establish follow-up communication links.

Networking Strategies

Strategy One: *Identify and solicit support from a population of mathematics education innovators, early adopters and opinion leaders.*

Project personnel invited recognized leaders in the mathematics education community to attend a full-day workshop. Invited participants included classroom teachers, mathematics district coordinators, and university instructors. All participants were active leaders in state and district professional mathematics organizations and were familiar with the vision and focus of NCTM (1989).

The purposes of the workshop were (a) to discuss the project goals and rapid dissemination strategies, (b) to familiarize the group with the features and pedagogic potential of the Casio OH-7000G, (c) to solicit suggestions concerning appropriate curricular and pedagogic applications for the graphing calculator for middle school mathematics, and (d) to identify a group of prospective leaders across the state who would serve as regional workshop facilitators. Collaborative problem solving strategies (Strudler, 1992) for decision making concerning the content and delivery of calculator workshops contributed to the success of the project in several ways. By gaining the support, drawing upon the expertise, and tapping the enthusiasm of recognized mathematics leaders and innovators, the project gained acceptability while community commitment to and ownership of the goals of the project was expanded.

Strategy Two: *Create a new leadership cohort from among the ranks.*

The identification of qualified facilitators is essential to the success of teacher networks designed to promote change (Watts & Castle, 1992). This project utilized a pyramid approach to identify potential workshop facilitators, provide inservice opportunities to classroom teachers, and distribute curricular materials. By expanding the leadership pool, distribution efforts and communication links were facilitated while commitment to the project was enhanced.

Forty-five classroom teachers and mathematics coordinators from across the state were selected for participation in the facilitators workshop. Although many of the workshop facilitators had been approached by project personnel to participate in the training efforts of the project based upon recommendations by the initial consulting group, several individuals volunteered for the project in response to state-wide efforts to solicit facilitators and participants. Interest in the project was extremely high due to the advanced support of the consultant-leaders and to the publicity concerning the calculator give-away for workshop participants.

Strategy Three: *Articulate the vision and model materials for the new leaders to disseminate.*

Thirty-five of the 45 individuals selected as workshop facilitators attended a facilitator's workshop designed to articulate the vision and model materials and methods for the distribution and training of 1500 middle school mathematics teachers. Workshop materials were developed by the project academic coordinators with advice and recommendations from the initial consultant group. Facilitators attended a one-day workshop with the purposes of (a) learning the features and operations of the Casio OH-7000G graphing calculator, (b) participating in modeling opportunities for problem solving and reasoning directed towards the middle school curriculum, and (c) discussing workshop coordination and facilitator responsibilities for distribution efforts. Modeling activities included a conservation of area and perimeter problem, population sampling activities, and probability experiments.

Each facilitator agreed to conduct workshops in one of the six regional Professional Development Centers (PDCs) across the state, at state mathematics teacher conferences, and during district meetings. Calculators and support materials were distributed to the six PDCs across the state for ease of transfer to the facilitators. Times for many of the workshops had already been reserved and advertised by the PDCs, so facilitators were able to sign-up to conduct specific workshops. Facilitators received stipends for conducting workshops once their obligations of training approximately fifty teachers each had been fulfilled.

Strategy Four: *Employ rapid dissemination strategies.*

Perhaps an over-looked component for affecting pedagogic and curricular change is the distribution strategy. Pilot sites or limited populations are often the only initial beneficiaries of new programs or innovations. A strength of this project was rapid dissemination strategies that had a wide-spread impact on the entire middle school mathematics education community. In less than a six-month period, 1500 middle school mathematics teachers attended workshops which modeled materials and discussed the vision of mathematics education specified by the project. Each teacher received an overhead graphing calculator for use in the teaching of mathematics at the middle school level. Because workshop facilitators were located throughout the state and associated with regional PDCs, opportunities for formal and continued communication links were maximized.

Strategy Five: *Establish follow-up communication links.*

Funding is currently being solicited for maintaining communication links and formalizing already existing informal communication networks. Even the most ambitious and well received innovation will falter if prolonged inservice opportunities are not available (Berman & McLaughlin, 1977). While teachers struggle with change and accommodate new meaning structures in their teaching paradigms, opportunities to share difficulties and successes are important. Educational change does not occur at the individual level within single classrooms, but entails a renegotiation within the entire mathematics education community.

With respect to this project, links among project personnel, facilitators, and teachers who attended calculator workshops have been erratic. Through other mathematics modeling grants, a handful of teachers have received prolonged support services and continued contact with university project personnel in the form of site visits and modeling of teaching strategies in the schools. More widespread efforts, however, are currently awaiting approval of funding agencies.

Conclusions

The networking strategies used in this project enabled teachers to establish a learning community with a shared vision of mathematics education which emphasized the applications for and uses of technology in the teaching of middle school mathematics. Disseminating curricular materials to and training over half of the middle school teachers in the state occurred in a very short period of time. In contrast with most inservice opportunities which have set agendas, teacher networks provide for discourse within the teaching community. Opportunities for professional growth and risk-taking are enhanced as networking communities place a value on the exploration and exchange of ideas. Still lacking in this project is the funding necessary to maintain formal communication links among project personnel, workshop facilitators, and classroom teachers participating in the project.

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District teacher teams integrating technology into the mathematics/ science curriculum

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Historically, technology was omitted in the study of mathematics. Although available for some time, calculators were typically allowed only after students had mastered the paper and pencil skills the technology could replace. For more than a decade, technology was often hidden from all but those students in the academic tracks. This perspective eliminated substantive experiences in mathematics exploration from most student work in K-12 education, in spite of the call for reform in mathematics and the growing availability of inexpensive, user-friendly equipment. Currently, however, technology has invaded the mathematics classroom, in part because of the reform movement supported by the National Council of Teachers of Mathematics (NCTM, 1989, 1991).

In the early stages of technology introduction, the equipment was often taught as a subject unto itself. Technology was often used to teach traditional topics - many of which were of less value because of technology. For example, many early instructional computing systems included drill and practice programs on such topics as the long division algorithm. In most schools, technology was not used uniformly or effectively by the entire staff, even in a given department or cluster. Often those who purchased or pursued the technology on their own used it, while others ignored it.

This project was designed to prepare teachers to use technology in a constructive and effective manner. The focus was on appropriate, effective use of the technology in the classroom and the dissemination of such uses to the entire mathematics staff in a district and the professional mathematics education community. In contrast to the typical approach of one teacher from a district exploring a new teaching activity, this project would prepare a district team to use the technology, to train others to use it effectively, and to provide district leadership in the use of technology. From discussions with leaders in the area of educational change, a team of five was considered for most effective support.

Procedures

Team Selection

The project extended over three years (Summer, 1990 - Spring, 1993). In contrast to many such projects where individual teachers participate and return to their schools to resume an existence in isolation, this project required district teams to participate. Ten districts from southeastern Wisconsin participated. The goal was to prepare these teams to be change agents in their districts and in the profession. In particular, the team members were to use technology appropriately in the teaching of mathematics as recommended in the mathematics reform in middle schools and high schools. Teams were expected to prepare and deliver staff development programs for their colleagues in the district, in other districts, and at professional meetings. In order to do that, each team was established with two middle school mathematics teachers, two high school mathematics teachers, and a non-mathematics teacher. The fifth teacher was from science, social studies, language arts, or an instructional support center. The non-mathematics teacher was included to give continual attention to applying mathematics and technology to the student learning environment across the curriculum. The strongest examples were in the use of statistics across the curriculum.

Due to the lateness of the grant award, many districts were not able to recruit teams fulfilling all of the criteria because summer plans had already been made by many individuals. Team selection was, therefore, adjusted. Six full teams were selected from Milwaukee suburban districts. The Milwaukee Public Schools, which was divided into six Regional Service Areas, submitted three teams, each from a different service area; one of these teams had only middle school membership when high school members from that region could not be recruited. (The school represented by this team was designated to become a mathematics/science middle school for the city.) One team of high school faculty from one district and middle school staff from a second district was created. Non-mathematics teachers included three physics/chemistry high school teachers, two life/earth science teachers (one high school, one middle school), a high school learning center coordinator with a background in language arts, a high school social studies teacher, and three middle school teachers with backgrounds in language arts and social studies.

Instructional Team

The project's instructional team required to deliver this wide array of skills and provide constructive support included university and school personnel. Major instruction was provided by a mathematics educator; a professor of applied mathematics; two educational psychologists with expertise in learning theory and education of minority and at-risk students, respectively; faculty in science education and social studies education; a professor in educational change strategies; and four highly skilled and recognized public school mathematics educators, including - two Presidential Awardees in Mathematics. This team worked with the participants at various points in the program and were available as resources throughout the project, for both instructors and participants.

First Year

The focus during the first year was on teacher awareness and increased competence with technology (calculators, computer software, manipulatives), expanded teacher knowledge of mathematics, and teacher awareness of new instructional strategies (e.g., cooperative learning, improved classroom discourse). This was an intense, often anxious experience for the project participants. Many felt exposed to much more material than they could master at one time. During the summer and the first school year, the participants experienced the need to focus on a small number of changes they could accomplish while keeping an awareness of next steps to take. The personal acceptance of being able to do a small amount of what they learned was a most critical lesson.

For many of the participants, an early change in curriculum was the inclusion of data analysis concepts and techniques. Data analysis activities were model settings for a range of mathematics reform expectations for both students and teachers. Motivation for standard mathematical topics and techniques could be generated from the experiential nature of data collection, organization, and interpretation in problems that students "owned." This approach eased the use of mathematics in other courses - social science, science, and even language arts - as well as the use of topics from those disciplines in mathematics. This approach blended well with not only reduced emphasis on computation and mastery of paper-pencil algorithms but also increased emphasis on estimation, mental arithmetic, and use of technology.

Three Saturday sessions were held throughout the year which encouraged sharing and reflection based on experiences with the technology and manipulatives and on student reactions. Key materials included Kepner (1988), NCTM (1989), Coxford and Shulte (1988), Lindquist and Shulte (1987), Grouws and Cooney (1988), and Wagner and Kieran (1989).

Second Year

During the second summer, there was a revisitation of the original topics and software with a planned extension to more refined classroom lesson plans and the preparation of staff development materials for use in district and professional meetings. The teams shared units in presentations and critiques, most involving technology as an everyday learning tool. This sharing was a major step in the encouragement of teachers to refine lessons through in-depth discussions with colleagues. This interaction is described as a mainstay of the Japanese system, but it is seldom used in this country, primarily because of the teacher workday, both scheduled and expected, which does not provide substantive time or expectations for teachers to share professional ideas on the fine-tuning of instruction. This sharing was exceptionally rich, in terms of teachers' providing constructive criticism, sharing student perspectives and alternatives, and addressing issues of assessing student performance beyond algorithm mastery and memorization.

In the second summer, the non-mathematics teachers produced examples of activities and lessons which applied statistics and other mathematical concepts and procedures to topics outside of school mathematics. A special focus on the constructive perspective on how students learn mathematics was included along with a full strand on dealing with at-risk students in an urban environment. Additionally, the mathematics teachers refined their skills with technology and with methods of implementation that were tried with various degrees of success during year one. Key materials included Joyce and Weil (1986), Kenelly (1989), Kulm (1990), Steen (1990), Kepner (1990), NCTM (1991), Cooney and Hirsch (1990), and Charles and Silver (1988).

Two Saturday sessions were held during the school year similar to the first year. A third Saturday was incorporated into a Wisconsin Mathematics Council full-day seminar on technology in mathematics attended by over 350 participants. It was hosted by one of the districts in the project under the leadership of that team.

Third Year

The third summer focused on extension of the previous topics along with a major focus on the teaching of algebra and algebraic reasoning and assessment with the forthcoming infusion of technology. In particular, participants studied uses of the Computer Intensive Algebra materials and the use of spreadsheets as powerful tools in the building of experimenting with rate of change and many of the standard algebra conceptual topics. There was also in-depth experimentation on geometry tools (e.g., Bennett, Hartman, & Rasmussen, 1991). Several participants have since begun to use these tools on a daily or weekly basis in instruction.

Issues and examples of alternative forms of assessment were continued. In addition, the teachers had a substantial exposure to the research on change and strategies of change for the school as an institution. Key materials included American Statistical Association (1991), and various NCTM publications produced in support of NCTM (1989, 1991). Two Saturday sessions are scheduled for the 1992-93 school year along with participation in a second annual technology conference held in the state.

Results

Survey data and daily logs on each of the teacher participants were collected annually, along with four classroom observations of each project teacher and interviews with building principals. While the analysis of these data are not complete, there are indications of the changes in teachers and changes in the district mathematics curriculum and staff development activities.

Individuals

Over the three-year project, 41 of the nearly 50 initial teachers remained in the project. Seven teachers withdrew from the program, mainly because of jobs changes. Most often, qualified teachers from the same school, who knew about and supported the project, replaced the departing participants. Throughout the period of study, teachers continued to refine their technology literacy and perspectives on incorporation of technology into the teaching and assessing of mathematics and related topics.

The majority of the curriculum work incorporated technology to motivate mathematical pattern development, applications, and discussion. In particular, there was significant focus on generating algebraic reasoning and selected representations of functions based on data collection activities. Teachers incorporated multiple representations of information in their instruction; for example, tables, charts, and graphs, symbolic representations (functions, equations, inequalities), and manipulative materials (algebra tiles, integer chips, geoboards, etc.).

Data for the first two years are now being analyzed on the change in teachers' beliefs about mathematics and the teaching of mathematics, as well as the frequency and types of use of technology in their classrooms. Individual teachers are showing a shift in their beliefs in what mathematics/statistics is and how students learn it. There are numerous examples of individual teacher changes in teaching and assessing students in their classroom. These changes are noted in assessment tools used in the classroom, instructional techniques employed, and frequency and variety of technology as a standard learning tool.

A subcategory of data identifies the expansion of student involvement in the use of statistics, not only in mathematics class but also in other classes. Participants have used statistical activities to increase student proficiency at discussing and critiquing arguments in the mathematics classroom. We also have reports of improved student communication through statistical settings. Often this may be improved by the opportunity for students to talk mathematics in a meaningful context. An accompanying result is the reported expansion of data analysis ideas to other teachers in the district. This focus on statistical perspective incorporates the use of technology for data collection (e.g., science probes), organization, and interpretation.

During the first year, the non-mathematics participants were often unsure of their role in the project as the emphasis was on gaining control of the technology and manipulative materials often used in mathematics. Because of that concern, two of these teachers withdrew before the start of the second summer session. In subsequent years, the non-mathematics participants became full working members of the project and their teams. They developed useful units for their own disciplines using appropriate mathematics and technology. These were shared with all the participants and used in other districts. The Learning Center Specialist, in particular, was a strong contributor to the inclusion of student communication skills and expectations in the mathematics classroom and beyond. The non-mathematics participants were strong, constructive critics of the mathematics units prepared by their team members; they constantly called for relevance in the instruction. They were valued members of the teams in building district plans for the inclusion of technology and the preparation of staff development to reach a wider faculty audience in their districts.

Team Impact

A reported impact of this project in all the districts has been an increased communication link between middle schools and high schools. During the first summer, it was clear that members of the district teams knew little about what was going on in other buildings in that district. Often little was known about the curriculum, materials (including text adoptions), technology, and supplementary publications. Team members from the same district often knew each other mainly through experiences outside of mathematics, such as members of the union bargaining team. On several teams, there was an initial underlying ranking of the high school teachers over middle school teachers.

Team members are now comfortable in planning district changes and working together as equals. In most districts, teams have met with and presented proposals to district leaders for equipment purchases, materials, and staff development plans. Several participants have been partially or totally reassigned to positions as computer coordinators for the district or the building. Partly as a result of this project, the mathematics reform effort is at least a coordinated 6-12 effort.

One of the teams has become dysfunctional due to continued changes and administrative disruptions in their urban schools. Several of the team members, however, are active participants and contribute to professional meetings and demonstrate personal growth in their new settings. Teams have given staff development to members of their building and in most cases to a wider audience within the district, in neighboring districts, or at professional meetings.

District Impact

Equally notable at this time is the impact that teams have made in their districts. The teams have undertaken leadership activities, such as staff development programs, conference presentations, state committee membership, and parent/community presentations. Reports on district and building changes from interviews with administrators are being compiled. All teams have had members influence district curriculum change. Most teams have initiated staff development activities with their colleagues.

At the conclusion of the summer program each year, the district superintendents, assistant superintendent for curriculum/instruction, and building principals were invited to an informational reception. During this reception, the teams presented their progress and proposals to their district decision-makers. This component has had a powerful impact in most of the districts. Each year, key decision-makers from all but one of the districts attended. (A different district was not represented each year.)

There is strong evidence, at several levels, of the effectiveness of district teams as change agents in providing improved technology use by students in middle and high schools. Similar coordinated efforts are needed to tie early childhood and elementary education to this plan. One district team has been recruited by a neighboring school district to serve as mentor of the high school mathematics faculty in that district.

Implications

This project has shown the power of providing professional development for teams of teachers from both middle and high schools in a district. Teams have had a major impact on educational change through use of technology in their districts. It is important to develop expertise in team members and then call attention to it. Often, the recognition of teacher expertise through an NSF-supported project was the needed clout to gain attention of the school administration and school board.

The project also demonstrates the slow, uneven rate at which substantive change takes place. While early results indicated minimal change in teachers' behaviors, their use of technology, and their impact on school change, extended observations over three years reveal growth in all these areas for a majority of the teachers. A long, sustained period of information processing and reflection was needed by the teachers before major changes were noted in their instruction, assessment, and professional leadership. In addition, the outside reminder of their expertise and an opportunity to share with other leaders was important in keeping change moving forward. Observations suggest how all-consuming the teacher workday is. Without external support, well-intended changes often do not materialize. Through an extended support system and continual reflection opportunities, many of the individual teachers have stepped forward as leaders of change in their buildings, and in several cases, beyond the buildings.

The non-mathematics participants were valuable members of the teams. They provided constructive criticism for the way mathematics is taught, and they presented many student views not often recognized by mathematics teachers. They called attention to the need for relevance and communication skills in the teaching and learning of mathematics in context. These participants added credibility to the teams with faculty, administration, and the school boards in the districts. Individuals involved in the project have become more active, aggressive agents for change in their districts. They are capable of presenting plans and proposals to building and district leaders as well as, in some cases, preparing proposals for outside funding agents. From this small sample of district teams, it is disconcerting to note the apparent limited impact on a large, urban district compared to team impact in the surrounding smaller districts.

This project provides a model for systemic change at the local, regional, and state level. Follow-up reports will document the program for such efforts.

This research was supported in part by a grant from the National Science Foundation, TPE 8954792. The opinions and views expressed in this paper do not necessarily express the views of the granting agency.

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Computers in physics instruction: A collaborative development of teaching strategies

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Research on the computer as a teaching medium has been almost totally neglected, and yet, systematic, classroom-based analysis of teaching with computers should be a prime research focus. Training teachers how to teach with a computer is a necessary prerequisite to the realization of the potential promised by technological implementation. Computer-based labs, interactive video discs, CD-ROMs, simulations, and multimedia presentations are only some of the computer-based technologies currently becoming economically feasible for introduction into physics education. An essential characteristic of all of these technologies is that they make it possible and, perhaps, even mandatory, to deliver instruction in ways fundamentally different from traditional approaches. Their implementation also results in the establishment of radically new and, hopefully, radically improved learning environments for the students. These changes present major challenges to physics teachers to revise their instructional strategies. However, although there is substantial research evidence that the use of computers can contribute significantly to the quality of physics learning (e.g., Ellis, 1992), that research has had little effect upon actual classroom practice. Few physics teachers are actually using the available technology. The majority of regular physics teachers have not been trained to use computers as teaching/learning devices. Thus, what is needed, is systematic, classroom-based research focused on training teachers to incorporate the new technologies effectively into existing educational programs. Inservice teacher development may be the key to increasing the use of computer-based technology in physics teaching.

This project addresses the specific need for developing effective, computer-based instructional strategies for physics education and the inservice training of physics teachers in the use of these strategies. This project is developing, *in situ*, and will communicate to potential users the teaching strategies and classroom procedures that promote the best use of a specific type of computer technology: computer-based simulations. When an English teacher sends students to the computer to write a composition, the computer is utilized mainly as a convenient mechanical device. Few new teaching techniques are involved. Many new teaching techniques are involved, however, when a physics teacher uses an interactive simulation program as a teaching and learning medium. These new techniques must be researched and disseminated within the teaching community. Recognizing the central role of teachers in the process of gathering and interpreting information within an educational setting, the project has been designed as a collaborative effort between the University of British Columbia (UBC) and two secondary schools in British Columbia, with the schools' two physics teachers participating as co-investigators. The essence of the project is training. Working together, the team is planning strategies to use simulations and related computer-based technology as both instructional and learning tools, observing and evaluating the implementation of these strategies, conducting interviews with students, and evaluating the resultant student learning.

The implementation of computer-based simulations in physics education is a pedagogical necessity—one essential to counteract the rapidly increasing problem of concept overload. There is no comparison between what students were expected to learn in high school physics 50 years ago and what they are expected to learn today, and the gap is constantly increasing. How can physics teachers ensure that the fundamentals of physics are properly addressed while simultaneously acknowledging new developments and applications? Fifty years ago, no student would have been expected to understand how a laser operates to produce a hologram, how a semiconductor chip can store megabytes of information, or how real-time images from Uranus can be relayed to their color TV. The complexity of the subject demands the use of new pedagogical strategies. Computer-based simulations provide students with powerful tools to learn physics in an interactive environment and to explore applications to a degree that is simply not possible by any other means. Training pilots to operate large aircraft is so complex it could not be done without simulators. It is now necessary to begin to educate our physics students in the same manner.

This project addresses the fact that the process of teaching may change in fundamental ways with the application of emerging computer technology. The results of the study will enable (a) development of instructional and implementation procedures to encourage and facilitate effective classroom use of computer-based simulations and (b) formulation of objectives, established upon demonstrable student outcomes, for the use of computer-based simulations in science classrooms. These procedures and objectives will be useful as policy guidelines for schools and districts wishing to broaden their scope of computer-based instruction to meet the challenges of the 21st Century. An indirect product of this project will be the training of the two teacher co-investigators to undertake their own field-based research. The communication of the results of the study to science teachers is an important aspect of the project and one in which all three team members will participate. In addition, the findings of the project will be implemented in science education courses at UBC and, therefore, will have direct input into the training of preservice science teachers.

Significance of the Project

The influx of computer technology into educational settings has stimulated many efforts to understand and assess the benefits and consequences, both affective and cognitive, of using computers. The most striking generalization that can be drawn from such efforts is that the computer has yet to fulfill its promise as an instructional and learning medium. Computer-based simulations, for example, have been termed the "rescuers" of classroom computer use - the vehicles that may unlock the promised educational potential of computers (Crookall, 1988). Through simulations, science students can undertake experiments and investigations normally considered impractical or impossible. However, claims of the educational benefits for the use of computer-based simulations need substantiation. The usual necessity of grouping students to work on simulations imposed by the scarcity of computers is thought to encourage Socratic dialogue among the students, promote task collaboration within the context of computer-supported learning, and help students confront and overcome explanatory preconceptions. Hounshell and Hill (1989) claim that computer utilization can result in improving both science attitudes and achievement and may encourage more students to pursue further studies or careers in science and technology. Factors such as teachers' and students' attitudes, extent of integration into the curriculum, and user interface with hardware and software may have as much impact on computer-based achievement as the technology itself. It is of critical social and educational importance, therefore, that the circumstances under which teachers and students can feel comfortable utilizing computer-based simulations as a natural and essential tool for learning be researched. Moreover, this research must be conducted in the normal context of use—the classroom—if realistic objectives for the use of computer-based simulations are to be established.

Many unsuccessful attempts to introduce computer-based instruction can be traced to the human factor - both of teacher and student. The first step in understanding, and possible enhancement, of the use of computers in an educational setting has to be focused on understanding the specific characteristics that computing presents in real educational settings and developing procedures to address them. Integration of technology and education is still a relatively new enterprise. Unfortunately, there is a serious scarcity of applicable theories from which to derive predictions of the effects ensuing from computer use in specific classroom situations. For example, problems that have been identified with the introduction of computer-based simulations include optimizing computer time and learner guidance, lack of teacher guidance for effectively implementing the software, reluctance of teachers to modify their teaching style to accommodate the computer, access to computers, lack of external incentives and peer support for the teacher, and lack of intrinsic motivators in the software. Most educationally interesting uses of computer-based simulations require adjustments in the traditional roles and instructional procedures of teachers. Many teachers understandably resist changing strategies that historically have proven to be successful for them. Moreover, teachers and curriculum designers must rethink the curriculum if computer-based simulations are to be successfully implemented—a process both groups are likely to resist without substantive evidence of the effectiveness of the computer technology. Bresler and Walker (1990), for example, emphasize that an innovation will not succeed unless it fits the patterns by which the teachers and students actually run their lives. To be effective, the application of computer-based technologies must be deeply integrated into the internal structure of the classroom. There is a crucial role for incorporating the computer within required versus voluntary curricular activities. Hardware acquisition, though necessary, is not equivalent to curricular innovation.

Innovation in the use of computer-based technology requires teacher change at three distinct levels: (a) actual use of the computer, (b) teaching approaches, and (c) beliefs (Fullen, 1982). To address these successfully, teaching research must be initiated which takes place in resource-rich environments and focuses on action-oriented instructional methodologies designed to support multi-leveled, outcome-based curriculum models. Research should also be undertaken that will provide specific guidelines for the development of assessments that will measure student learning resulting from computer-enhanced instruction. It is only through systematic investigation and resolution of the issue of appropriate teacher training related to classroom utilization of emerging educational technologies, that these technologies will become key components in establishing improved learning environments.

Project Design

The design of the project was predicated upon the premise that, to be successful, technology implementation models require the involvement of practicing classroom teachers within their own classrooms, frequent communication among the participating teachers and researchers, and access to long-term funding. Too, participating students must perceive their use of computer technology and that of their teachers as an integral part of the normal classroom procedures rather than as some special feature introduced by a research program. As Soloman (1991) notes, computer-enhanced classrooms are "complex, often nested conglomerates of interdependent variables, events, perceptions, attitudes, expectations, and behaviors, and thus their study cannot be approached in the same way that the study of single events and single variables can" (p. 11). For these reasons, a qualitative, quasi-experimental methodology will be used: one of intensive, in-class, observations over an extended period of time coupled with data collection and analysis. The project has been designed as a multi-site, action research, case study based upon a partnership between the project leader and two collaborating physics teachers. Plans and teaching strategies for implementing the computer-based simulation will be developed and evaluated collectively by the team. The actual classroom teaching will be done by the participating teachers as an integral part of their classroom instruction. The project leader will be responsible for directing the focus of the research and will observe, record and document the classroom use of the simulation and related technologies, conduct interviews with students, assess the attitudes and learning of the students, and prepare all reports. The following specific research questions were developed:

1. What are the necessary and sufficient conditions for the successful implementation of computer-based simulations in physics education?
2. What are the most effective strategies of incorporating computer-based simulations into the teaching of physics?
3. What are the outcomes of incorporating computer-based simulations into physics curricula?

The use of an exemplary simulation was deemed to be critical to the success of the project. Interactive Physics II™ was selected on the basis of design, versatility, fit to the existing curriculum, appeal both to students and teachers, and the fact that the publishers of the prescribed British Columbia Physics 12 textbook are developing a teacher resource package of interactive student exercises based upon this simulation. Interactive Physics II™ can be used for demonstration and simulation purposes, as part of a lecture/discussion, and as a student learning tool.

The criteria for the selection of the collaborating teachers included teaching and computer experience, leadership qualities, ability to work together, availability of school resources, and proximity of their schools. The first teacher has been teaching physics, science, mathematics, and computer science for eleven years. Currently, he is the science department head in his school, is involved in inservice activities in his school district, and is a member of the BC section of the American Association of Physics Teachers (AAPT) executive committee. The second teacher has been teaching physics, science, and mathematics for five years. He is also involved in inservice activities and is currently president of the BC section of the AAPT executive committee. He trained as a student teacher with the first teacher, and, after receiving his teaching certificate, taught for one year at the same school before transferring to a neighboring school. The two have since collaborated on developing computer-based physics assessment instruments and procedures. Both teachers use Macintosh computers extensively as professional tools to develop planning and lesson materials and to administer physics exams. Neither had used a computer as an instructional tool prior to joining the project. The support of educational administrators is always of enormous benefit to action-research studies. The cooperation and enthusiasm of the school and district administrators contributed significantly to the selection of the two teacher collaborators. For example, both teachers are going to be provided with some release time to work on the project, and both schools have made modifications to the physics classrooms to accommodate student and teacher workstations and to enhance security.

Project Status

An examination of the first research question necessitated consideration of (a) the degree to which the teachers and students would need to change their established roles and behaviors to implement the computer-based simulation successfully, (b) the adjustments necessary to incorporate the simulation into the existing course structure, and (c) the provision of adequate equipment and facilities for students and teachers. It has been decided that each teacher station will optimally require a high speed color projection panel and at least a Macintosh IIci computer with 8M RAM and a 230M hard drive and that each classroom will require ten Macintosh IIci student workstations. These facilities were judged to be not only sufficient for the requirements of running Interactive Physics II™ but also sophisticated enough not to be too quickly made obsolescent by inevitable technological change.

Both teachers have begun experimenting with the use of the simulation on a small scale pending the acquisition of all the necessary equipment. For example, the first teacher has simulated several of the prescribed Physics 12 lab exercises and given his students the choice of completing the lab using the computer or using the standard lab equipment. At the time, the classroom had only four computers. Approximately half of the class chose the computer option. Whether the student response would have been unanimous had there been adequate hardware remains moot. The students who performed the simulated laboratories were given only minimal instruction on the operation of the program. All were overwhelmingly positive towards the procedure in their written reactions. The reasons underlying this strong response will be subjected to careful study and analysis. The student responses also indicated that they would welcome further use of the simulation in their course but would prefer individual access to the computers. One student noted that the program would permit them to simulate problems that would be difficult to study in "the real world." Another indicated that it would be nice if they could use the program to help figure out assignment problems with which they were experiencing difficulty. All of the responding students felt that the simulation was a reasonable representation of the real world and was relatively easy to use.

Preparation is being made to use multimedia technology extensively throughout the project. Video is being used to record and examine selected lessons and procedures and to record student interviews. These videos will constitute the primary data of the project. They will be examined, edited, and eventually assembled into video disc format for workshop presentations and training purposes. An existing HyperCard application will permit the interactive viewing of this disc, the clustering of observations, and the addition of written observations and suggestions. This multimedia approach will give the team an opportunity to challenge previously-held notions of what constitutes good physics teaching.

Conclusions

This project is aimed at investigating the integration of computer-based technologies into existing curricula and the development of relevant instructional strategies that promote student learning, critical thinking, and problem solving. Research in education should always reflect and respond to real instructional needs. The introduction of computer-based technologies into education has created a specific need for research into new teaching strategies which effectively incorporate these technologies and which result in a change, and hopefully an improvement, of the pedagogical process and product. Such research is necessary to prevent the use of technology to reinforce outmoded, ineffective methods for teaching and learning. As alluring and exciting as technology seems in the abstract, at the classroom level its implementation must support teachers in the adoption of improved teaching practices and improved methods for managing the learning of their students. Computer-based simulations, in particular, permit the attainment of learning goals beyond the capabilities of traditional instructional modes. They may also be the stimulus needed to attract more secondary students into science and technology studies and to curb rising school dropout rates. Traditional teaching strategies are obviously not adequately meeting the needs of today's students and effective pedagogical use of computer-based technology is still rare. It is critical, therefore, that science teachers be trained to use computer-based simulations effectively in their classrooms and that changes which accrue from the introduction and use of computer-based simulations be subjected to detailed and systematic scrutiny. For too long, computers have simply been added to school equipment with the untested assumption that they represent valuable teaching and learning tools. However, little correlation between computer-acquisition and improvements in student learning has been demonstrated, for the simple reason that appropriate programs for the training of teachers to use computers as fundamental teaching devices have not been developed. Vast resources are consumed every year through unexamined biases of what the future should be. The development of educational policy guidelines should be based upon something more substantive. What education research should provide is data that can be converted to operational philosophies and procedures in the classroom. The goal of this project is to develop reliable data upon which developments in physics education can be built. Technological novelty is always attractive but the novelty must not be the basis of educational pursuits.

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Using multimedia with preservice and inservice teachers: Interpretations of whole number operations

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Brownell (1990) believes that "computing technology is as important an occurrence in human development as the advent of the written word over the oral tradition, as important as the invention of the printing press" (p. 8). If computer technology is truly such a momentous development, then it must eventually have a significant and crucial impact in the classroom.

It has often been said that teachers tend to teach as they have been taught and yet we find that the "vast majority of today's teachers have little or no training in the use of new technologies" (Scrogan, cited in Jongejan, 1990, p. 3). It is, therefore, not surprising that although the microcomputer was introduced to the elementary and secondary classrooms over a decade ago, the instructional process at all levels has remained predominantly unchanged (Jongejan, 1990).

Much of the training that preservice and inservice teachers receive involves learning about computers rather than how to use them in instruction. It is important that teachers learn about technology, but they must also learn how to incorporate technology into their teaching. This includes using the computer as a teacher tool as well as a teaching and learning tool. Byers (1990) points out that "the computer using educator is the regular classroom teacher" (p. 9) and, therefore, "all teachers should become computer users at some appropriate level" (p. 9).

It is essential that colleges of education provide programs that will prepare inservice and preservice teachers to use various technologies to assist in (a) the preparation of instruction, (b) the instructional process, and (c) the learning process. In order to accomplish this, technology must be used in each of these areas in the methods courses that preservice and inservice teachers take. "Colleges of education must provide programs to assist professors in learning to use computers as personal and professional tools and to assist them in redesigning their courses to integrate the capabilities of the computer" and "methods courses must consider the development of lessons that integrate computing technology" (Niess, 1990, p. 14). Strudler (1991) agrees that "it is imperative ... that teacher education models the use of technology in their own instruction as well as integrate relevant computer-based technologies into appropriate methods courses" (p. 5).

As Kearsley, Hunter, and Furlong (1992) indicate, mathematics education has used computers for many years. Originally, the majority of programs for mathematics particularly at the elementary level were drill and practice programs. At the secondary level, programming was used to provide an opportunity to solve problems in mathematics. Today the use of technology in mathematics can and should range from using the computer for traditional computer-assisted instruction to the incorporation of multimedia into the mathematics curriculum. "The power of computers ... needs to be used in contemporary mathematics programs. ... The thoughtful and creative use of technology can greatly improve the quality of the curriculum and the quality of children's learning" (National Council of Teachers of Mathematics [NCTM], 1989, p. 19).

To develop "creative use of technology" it was necessary to determine an area of the mathematics methods curriculum we felt would benefit from the use of multimedia. NCTM (1989) emphasizes problem solving in the first standard for K-4 and concepts of whole number operations in the seventh K-4 standard. Interpretations (problem situations) of whole number operations are important topics in K-4 mathematics. Unfortunately, in too many K-4 classrooms, students learn the whole number operations in terms of "tables" to be memorized rather than understanding that each operation represents various situations. Children must develop conceptual understanding of the four whole number operations through experiences that allow analysis of these situations. Therefore, experiences with each of these situations must be provided by the classroom teacher at the appropriate levels. Many K-4 teachers are not aware of the different interpretations for operations. If these teachers are to provide systematic instruction in these various interpretations, it is necessary that they also learn to recognize and analyze these interpretations (Anghileri & Johnson, 1992; Moser, 1992; Troutman & Lichtenberg, 1987).

To provide inservice and preservice teachers with experiences in using new technologies in elementary mathematics methods, the mathematics education faculty at the University of Southwestern Louisiana developed a multimedia unit (The Whole Number Operations Multimedia Unit) to assist in understanding these interpretations (or situations) for the four whole number operations. Tan, Yong, and Ng (1991) indicated that "hypermedia is suitable for the development of teachware as it provides features for planning, designing, and organizing of teaching materials" (p. 19).

The multimedia unit includes the use of a HyperCard stack and a commercial laser disc. The HyperCard stack is used to give appropriate information from NCTM (1989), present all interpretations of each whole number operation, and provide animated graphic or video representations of these interpretations. The stack also includes opportunities for the user to check understanding of the interpretations and experiences involving the use of manipulatives to better understand the operations.

The multimedia unit is used with both undergraduate and graduate mathematics methods classes during regular instruction on whole number operations. It is first used as a presentational tool with the HyperCard stack providing information to teach the five interpretations of addition (joining, comparison, missing sum, partition, and increment). These interpretations are presented with action video from a laser disc (AIMS Media's *Mathematics for the Primary Grades*) for the joining interpretation and animated graphics for the other four interpretations. During this instruction students are also given hands-on experiences using manipulatives to replicate the examples given in the presentation. Following the classroom use of the multimedia, students may also use the HyperCard stack and laser disc individually to reinforce the concepts taught. These materials are located in the College of Education's Educational Technology Review Center (ETRC).

When subtraction is introduced, the unit is again used to introduce the five interpretations of subtraction (take away, comparison, missing addend, partition, and increment). Some of these interpretations have several subtypes. Each subtype is explained and illustrated. Again, video from the laser disc and animated graphics are used as well as experiences with manipulatives, and students can use the unit individually in the ETRC. The same procedure is used to teach the interpretations for multiplication (additive, array, Cartesian, missing product, and ratio) and division (subtractive, distributive, missing factor, and ratio).

We believe that the use of materials such as the Whole Number Operations Multimedia Unit provides K-4 mathematics education students with several experiences. First, inservice and preservice teachers have the opportunity to learn in the way in which we hope they will teach — using technology in the classroom. Second, they experience the integration of technology into the curriculum. Third, they have the opportunity to use computers and laser discs. This provides students with hands-on use of technology to enhance learning. Fourth, they experience the use of two important and valuable assets in teaching mathematics (Perl, 1990) — the computer and manipulatives. It is imperative that children learn mathematics using manipulatives. Technology can be used to model, guide and manage the use of manipulatives (Perl, 1990) in the teaching of mathematics. This unit provides an example of this partnership. Fifth, the unit provides a method of interaction between the learner and the computer to reinforce concepts learned.

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What is computer literacy for a mathematics teacher?

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As with any current topic in mathematics or computer science education, it seems essential to initially announce or justify the philosophical perspective of its authors. This is where we wish to begin. Drawing upon our experiences and placing them within a philosophical framework enables us to better prepare, anticipate, and deal with the difficulties encountered.

Kaput (1992) pointed out that computers have been available to the classroom teacher for less than 10 years. In the recent past most of the difficulties have been with the hardware. In the future the difficulties probably will lie with the limitations of user thinking and insufficient software of a type which is designed to develop understanding. This is one of the major reasons why the authors believe that computer literacy for the classroom teacher is closely related to the subject being taught.

Currently there are two predominate perspectives on learning which lie at opposite ends of a continuous spectrum. These are behaviorism and constructivism. The purpose for acknowledging these two perspectives is that our framework is based on the constructivist philosophy. Most of the available software appears to be based on a behaviorist philosophy. It is our belief that this type of software does not provide the learning environment we seek.

Behaviorism in Education

The behaviorist approach to learning has been very useful for those who believe that the goal of mathematics instruction is to transmit the content of the subject or the accumulated "knowledge" of the field into their students' heads. It provides a justifiable means for determining if the instruction has met predefined goals. However, it seldom provides any insight into what is actually going on in the student's head. It merely provides some measurable construct which has not relied on subjective material as a basis for reporting results. Behaviorism assumes that any mental activity worth noting can be measured in some objective fashion. This is quite contrary to a contructivist perspective which suggests that it is this mental activity which is of greatest concern and that it is best explored on a more subjective basis, such as through an interactive dialogue or discussion. Mere memorization of procedures or facts seldom provides a sound basis for understanding, and it is understanding which most teachers would emphasize as a goal of instruction, especially in mathematics.

Learning Mathematics Instrumentally

Skemp (1978) has proposed two distinctly different approaches toward the teaching or learning of mathematics: relational and instrumental. The relational framework is similar in scope to the constructivist philosophy on learning. It suggests that learning requires an interconnecting network of related ideas and concepts from which new concepts may be formed. It also suggests that what most teachers strive for is this relational type of learning. However, what most teachers have experienced first hand is what might be called instrumental learning. Instrumental learning tends to focus on isolated bits of information as the central focus of mathematics instruction. This is evident, for example, when students are asked to memorize addition or multiplication tables. They tend to learn these facts in isolation, rather than as an interrelated network of ideas, thus requiring much greater effort to retain or embed within some meaningful mental structure. Another good example is when students are asked to determine the area of a rectangle. They merely recall that it is length times width without having any deeper understanding of what is meant by area. They know how to compute the area but do not have any real understanding of the relationship between the units involved and the space being covered.

Learning as a Constructive Activity for Teachers

The constructivist perspective on learning requires active participation on the part of the individual. To learn in a constructive sense implies the creation of new knowledge based upon existing mental or cognitive structures. For constructivists, acquiring knowledge is not a transmittal activity but rather a building process requiring direct involvement and reflection on the cognitive schema or operations being constructed by the individual. This suggests, therefore, that one becomes computer literate only through active participation. Being placed in front of a monitor or CRT does not in effect transmit anything more than several hundred thousand electrons; it does not transmit the knowledge or understanding necessary to efficiently utilize such technology. It is with this framework in mind that we have approached the concept of computer literacy.

Defining Computer Literacy for Mathematics Teachers

Microcomputers in the mathematics classroom have become one of the main concerns for public school teachers. On Guam, teachers are faced with using networked computer laboratories with little knowledge of how to operate or utilize a microcomputer. People in the local school system responsible for computer use and education have tried to solve this problem by training technicians to operate the file system without the teacher being included in the process. This accomplishes two things. First, it removes the teacher from a significant part of the educational endeavor, and second, it tends to restrict computer use to drill and practice with the machine as record keeper. Removing the teacher from a part of the educational process is a mistake. It tends to reinforce the feelings of disdain, indifference, and outright fear of the technology to which unfamiliarity with microcomputers leads.

As a suggested partial solution we have designed an inservice course for mathematics teachers which is believed to address several of the problems faced by these teachers. However, the teachers' unfamiliarity with the technology has led to the design of a course which attempts to educate as well as train. It is our contention that teachers must become computer literate within the context of learning to utilize the technology in their specific classrooms. The course mentioned above was the result of several requests by mathematics teachers to assist them in learning to utilize computer technology. The process of designing such a course raised two very complex questions: "What is computer literacy?" and "Is it possible that computer literacy might depend upon the subject being taught?" These questions have led us to believe that a definition of computer literacy for mathematics teachers should reflect the various needs of those teachers.

It is apparent that for mathematics teachers to have an adequate working knowledge implies more than being able to turn on a microcomputer, load a program, and run a given software package. Mathematics teachers should also be able to do the following (Singh, 1992):

1. Evaluate a given software package for use in a particular classroom.
2. Understand and use the microcomputer as tool for exploration of ideas and for concept development.
3. Assist students in the use of microcomputers for exploration of ideas and concepts.
4. Use and assist students in utilizing the microcomputer as a tool for problem solving in the classroom.
5. Have a working knowledge of LOGO.

Our working definition of computer literacy for mathematics teachers provides a basis for an inservice course. From this working definition several questions were derived. First, what do mathematics teachers need to know and what should they be able to do? Second, following directly from the first, what should the content of such a computer literacy course be? In the effort to answer these questions, a crucial third question arose: What is the philosophical framework on which the course should be designed and that the mathematics teachers should apply when they make use of their new knowledge? Although the third question developed from the first two it is clear that this question must be answered before the others. The first question is in a limited sense answered in the working definition of computer literacy but it needs to be examined in more detail.

1. Evaluate Software Packages

In a review of the research literature on computer-based instruction, Kulik and Kulik (1987) reported that many but not all studies indicate that computer-based instruction does raise student achievement. Hativa (1988 - a) noted (a) that many schools use computers mostly for drill and practice and (b) that computer-based practice did raise achievement scores though the gain with high achieving students was greater than with low achieving students. Hativa (1988 - b) documented some of the difficulties which arose with a particular computer-based drill and practice program. The designers of the program gave reasons why they had used a particular approach. Difficulties such as no remediation tutorials and timed exercises did create problems for some of the students. These results suggest that computer-based drill and practice programs have a place, but difficulties do arise, and the teacher needs to have considerable experience evaluating and analyzing these programs in order to be able to use them effectively.

2. Microcomputer as Tool for Exploration of Ideas and for Concept Development

Using a microcomputer for exploration can be done in a variety of ways. Several available programs have been designed with exploration and concept development in mind. Other programs, though not specifically designed this way, can be used for exploration and concept development when they are in the hands of a teacher who has the inclination and the experience to do so. One place to begin to acquire the needed experience is in a properly designed computer literacy course. The inclination to use computers in an exploratory fashion often results from learning "how to do it." Learning how to do it is directly related to experience. Examples of the use of a microcomputer in this manner may be found in programs such as *The Geometric Supposer: Quadrilaterals.* This program permits students to do things such as construct a variety of quadrilaterals and to connect the midpoints of the sides of the quadrilaterals. The instructor might then ask that students use the program to form conclusions based on the constructed figures and to make a variety of conjectures. If the course is at an appropriate level, proofs of these conjectures might follow. A second example of the use of a computer for exploration and reflection can be found in the program, *Derive*, which among other things will draw an accurate graph of a function. Students could be asked to graph a particular function which is the derivative of another function. Once this is done the graph could then be investigated to see what information it provides about the original function.

3. Assist Students in Exploring Ideas and Concepts

Although this part of the working definition of computer literacy is somewhat different in intent than part two, the process of accomplishing it is very much the same. Much of what has already been said applies here.

4. Assist Students in Problem Solving

This is related to but not identical to the previous category. The teacher needs to have a variety of experiences and considerable knowledge to do this effectively. One of the major goals of a computer literacy course such as described in this paper is to begin to provide the teacher with both the experiences and the subsequent knowledge.

5. Working Knowledge of Logo

This part of the working definition of computer literacy is described in the discussion of course content.

A Computer Literacy Course

The next question is that of content. What should be taught to help mathematics teachers become computer literate? Since these teachers are going to utilize the microcomputer to assist mathematics instruction, it is important to decide (a) what mathematics content is to be taught and (b) how this content is to be taught, before making a decision on what the teacher needs to know about microcomputers. The National Council of Teachers of Mathematics (NCTM, 1989) puts problem solving as the first standard in all three divisions of the grades K-12. The constructivist approach to learning suggests that knowledge is not conveyed from the teacher to the learner, but it must be actively constructed in the mind of the learner. The computer is a tool which can assist with both of these objectives. With these two objectives in mind the authors have developed a one semester course with several components.

Logo

It is our belief that some experience with a high level language is necessary to understand thoroughly how programs work and what can and cannot be done with microcomputers. Knowledge of such a language also permits teachers to begin to develop their own programs to fill in where commercially available programs do not appear to be adaptable to the needs of the moment. Logo was chosen for several reasons. It is not necessary for the beginner to master a complicated syntax in order to get started. It very quickly allows the user to begin to write procedures. Error messages in Logo are helpful and less difficult for the novice to understand than in many other languages. Some researchers have found that teachers who learned Logo exhibited less mathematics anxiety than teachers who learned BASIC. This could be of importance to some of the less well prepared middle school and elementary school teachers. Too, Logo may be used to do mathematics other than the geometry which many of us have become familiar through the use of turtle graphics. Cuoco (1990) discussed several non geometric topics such as functions, number theory, and combinatorics. Lewis (1990) used Logo to explore such topics as analytic geometry, vectors and vector operations, and linear transformations. There are other languages such as Scheme, another dialect of LISP, which will do these things quite well but they often require more computer capacity than many teachers have available.

Analyses of Software

There is a large variety of software available and it is necessary for the teacher to decide how and when to use it in the classroom. There are many sources of information available to help the teacher evaluate software. This information along with reviews of specific pieces of software can help the teacher make decisions about particular programs and how to use them in a given class. This course provides the teacher both the opportunity to investigate and analyze software and learn where to find information about software. The teacher is also required to plan ways in which the software may be effectively used in a class with a particular group of students.

Adaptation of Software

Although some of the software available may not do just what the teacher wishes to accomplish, it still may have potential. With such software a teacher with the proper experiences may well be able to adapt the software to fit the needs of a given class. Ability of this type would extend the usefulness of much of the software available to many teachers. An example of this might well be the modification of the use of a drill and practice computer lesson to explore a new idea or to extend a student's grasp of a given concept. The use of commercially available software for the development and exploration of new ideas is important for the computer literate mathematics teacher. Often this requires more than routine use as presented in a manual. The teacher needs to develop the knowledge necessary to find different and novel ways to use such software. The computer literacy course we have developed requires the teacher to work with particular software and to find ways to change its use to obtain goals somewhat different from the one presented by the software developers.

Development of Specific Curriculum

If the teacher is to make effective use of what was learned, it is necessary to know where, when, and how to integrate the microcomputer into the curriculum. One part of this course is to have the teachers take their curriculum and modify it to include the use of microcomputers.

Conclusions and Recommendations

An obvious question to be answered about a computer literacy course for mathematics teachers is "What should I gain from this course?" It is clear to anyone teaching mathematics at the secondary or tertiary level that technology is having a major impact on what we teach and how it is to be taught. Therefore, it is essential that computer literate teachers be able to adapt this technology to meet their instructional goals. With the advent of various operating systems such as DOS, HyperCard, Windows, and networked systems such as Novelle and AppleTalk, it is no longer sufficient to load a disk into an Apple II computer. Teachers must be knowledgeable about the available software for their particular system. They need to know not only how to operate their system but also how to use such software competently and efficiently. Knowing how to use such programs as the *Geometric Supposers*, *Green Globs*, *Maple*, *Mathematica*, and *Derive* are becoming essential. Development of Logo microworlds and their potential for exploration of concepts and conjecturing are also essential elements for any technologically advanced curriculum. The notion of computer literacy is constantly changing and what is sufficient for a computer literate mathematics teacher today will certainly not be sufficient tomorrow. This is just one of the many reasons for inservice training as described in this paper. It is also one of the major reasons why computer literacy must be viewed as being a content specific notion. Otherwise, the technology will soon become too great an obstacle for any one teacher to command within a classroom, and the idea of trained technicians orchestrating drill and practice routines will become a reality.

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The graphing calculator in mathematics concept development and problem-solving

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Many students enter college with weak skills in mathematics and elementary algebra. Past investigators have studied the effects of various teaching strategies in the area of algebra, the nature of spatial ability and its relation to mathematical problem-solving ability, the relationship between cognitive level and success in mathematics, and the effects of a symbol manipulator in the teaching of mathematics. Studies have shown that general spatial ability is significantly correlated with achievement in mathematics (Fennema & Sherman, 1978). Because of this, spatial ability is of special interest to mathematics educators.

Iben (1985/1986) suggests that what takes place in the mathematics classroom has a significant influence on a student's development of space relation and abstract mathematical thought. Since studies have shown that spatial ability is a reasonable predictor of general problem-solving ability (Rolen, 1985), educators could ask whether the use of a graphing calculator would lead to enhancement of a student's spatial skills and abstract problem-solving abilities. Research has shown that pictorial representations provide concrete examples of concepts to the learner and aid in further abstraction (Alesandrini, 1984). Holliday (1975) has reported that information delivered verbally supported by visual representation helps the adult learn new concepts better than verbal representation alone.

The effect of the graphing calculator upon the general cognitive processes required of the student in an elementary algebra course is worthy of investigation. Piaget's (1971) theory of learning suggests that academic achievement is influenced by a subject's cognitive level and the manner in which the subject is taught. Studies have found that many college students have not achieved a formal-operational level of cognitive development (Lawson, Nordland, & DeVito, 1975 check date) and yet formal-operational thinking is necessary for the understanding of many mathematical concepts included in elementary algebra (Collis, 1973, 1974, 1975). The graphing calculator provides opportunities for concrete visual investigation of algebraic topics, supporting the learning experience of the older concrete operational individual. This experience could lead to the use of higher-order thinking skills by the student.

Purposes and Procedures

During the Fall of 1990, a two-purpose study was conducted at the College of New Rochelle (Shoaf-Grubbs, 1992). The first purpose was to investigate the effect of the graphing calculator on students' general spatial ability. In addition, the effect of the graphing calculator was investigated in each of three topics in an elementary college algebra course in which visualization plays a particularly important role:

1. Linear Equations
2. Systems of Linear Equations
3. Parabolas

The second purpose was to examine the effect of the graphing calculator upon the general cognitive processes required of the student in the course. As in the case of spatial visualization, the student's level of understanding in the mathematical concepts was examined in two perspectives: first, in terms of the general cognitive level or level of understanding, and second, in terms of level of understanding in each of the three specific topics.

The goal was to present the algebra topics in a manner supporting Bruner's (1960) 'act of discovery' concept. The control group was taught using a more traditional method of instruction. This traditional method, however, was not carried out in a pure lecture mode of instruction. Graphs were presented in detail in the control group sessions. In the experimental group the graphs were created using the TI-81 graphing calculator, whereas in the control group the graphs were viewed by using overhead transparencies and sketches on graph paper. Care was taken that the lessons and delivery by the instructor, time on task, and number of graphs examined by each group were the same. Both sections were taught by the investigator.

During the semester the students were pre- and posttested for general spatial skills level and level of understanding in elementary algebra and graphs using the following instruments:

1. Spatial Skills
    a. Card Rotations Test, S-1
    b. Paper Folding Test, VZ-2
2. Algebra and Graphs
    a. Chelsea Diagnostic Mathematics Tests-Algebra
    b. Chelsea Diagnostic Mathematics Tests-Graphs

The Chelsea tests were developed as a means to measure and identify a hierarchy of understanding connecting mathematical concepts (Brown, Hart, & Kuchemann, 1985). Since the emphasis was on level of understanding, the tests contained relatively few items requiring routine mechanical skills (Hart, Brown, Kerslake, Kuchemann, & Ruddock, 1985). Posttests were administered at the conclusion of the course to determine how much growth, if any, occurred during the semester.

Students were also pre- and posttested for specific spatial ability skills and level of understanding in each of the three specific algebra topics. After posttesting, exploratory data analysis was carried out in the form of scattergrams. The scattergrams were vital in that they not only rendered a pictorial representation of what was occurring from pretest to posttest but also depicted the progress, or lack thereof, of each individual student and class. The two-sample *t*-statistic was calculated for the gains (difference in the posttest and pretest scores) in each of the reported nineteen tests and test combinations.

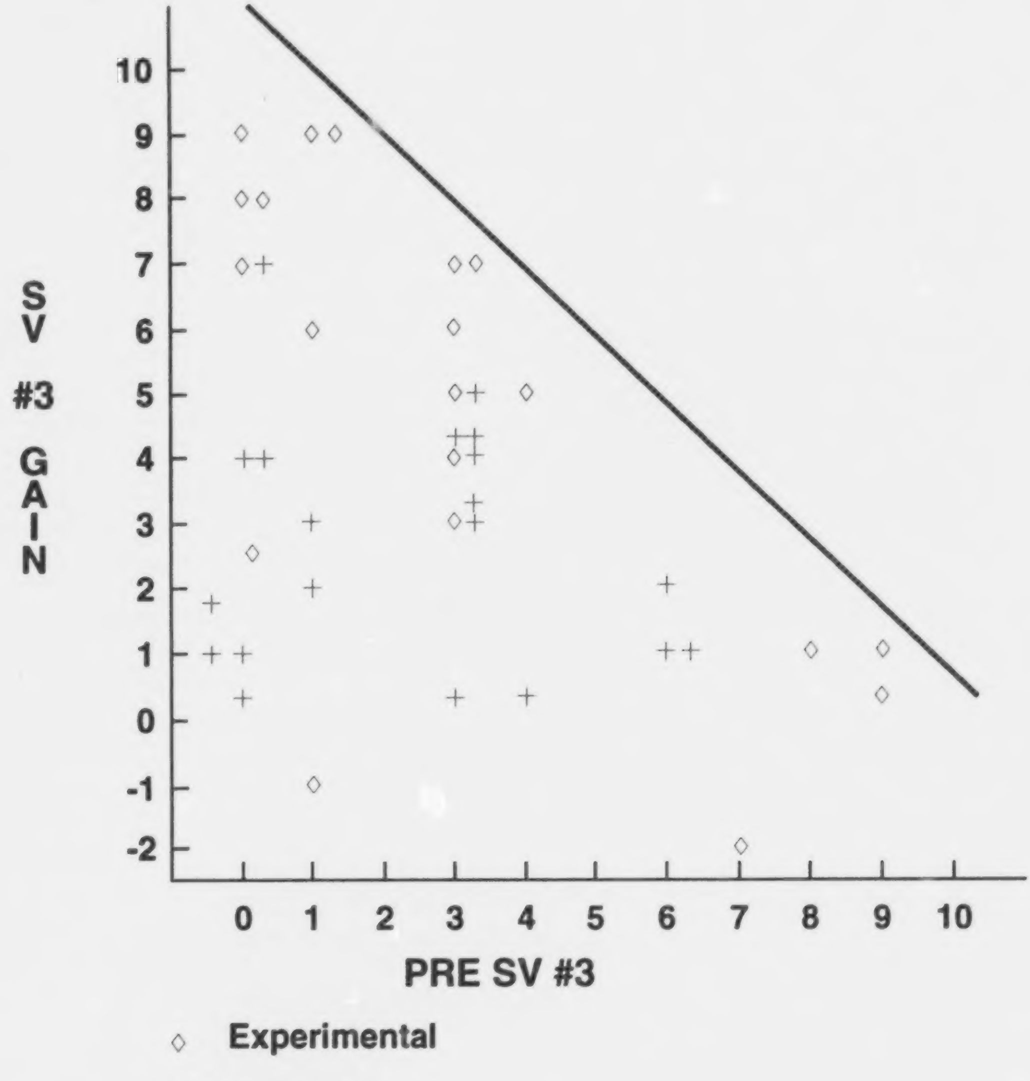
Results

In order to fully understand how the visual and statistical data analysis was carried out, two tests will be discussed in detail followed by a summary of the other seventeen tests and test combinations. The Chelsea Graphs test consists of three levels - from Level I consisting of the most elementary concepts to Level 3 involving the most advanced concepts. In addition to examining the results for each level, the Total Graphs Test consisting of all three levels totaling 24 items was analyzed. Scattergram #1 (Figure 1) plots each student's pretest score on the x-axis and her corresponding gain on the y-axis. The investigator also included a diagonal 'perfection' line to aid in the visual interpretation of the data. A scattergram using the diagonal line indicator of post score 'perfection' serves as an excellent visual representation of both of these factors simultaneously. From the scattergram, information can be obtained about the subject's beginning performance, the amount of gain, and how successful the subject was in striving for 'perfection'

Table 1
Descriptive Statistics of the Graphs Tests Total

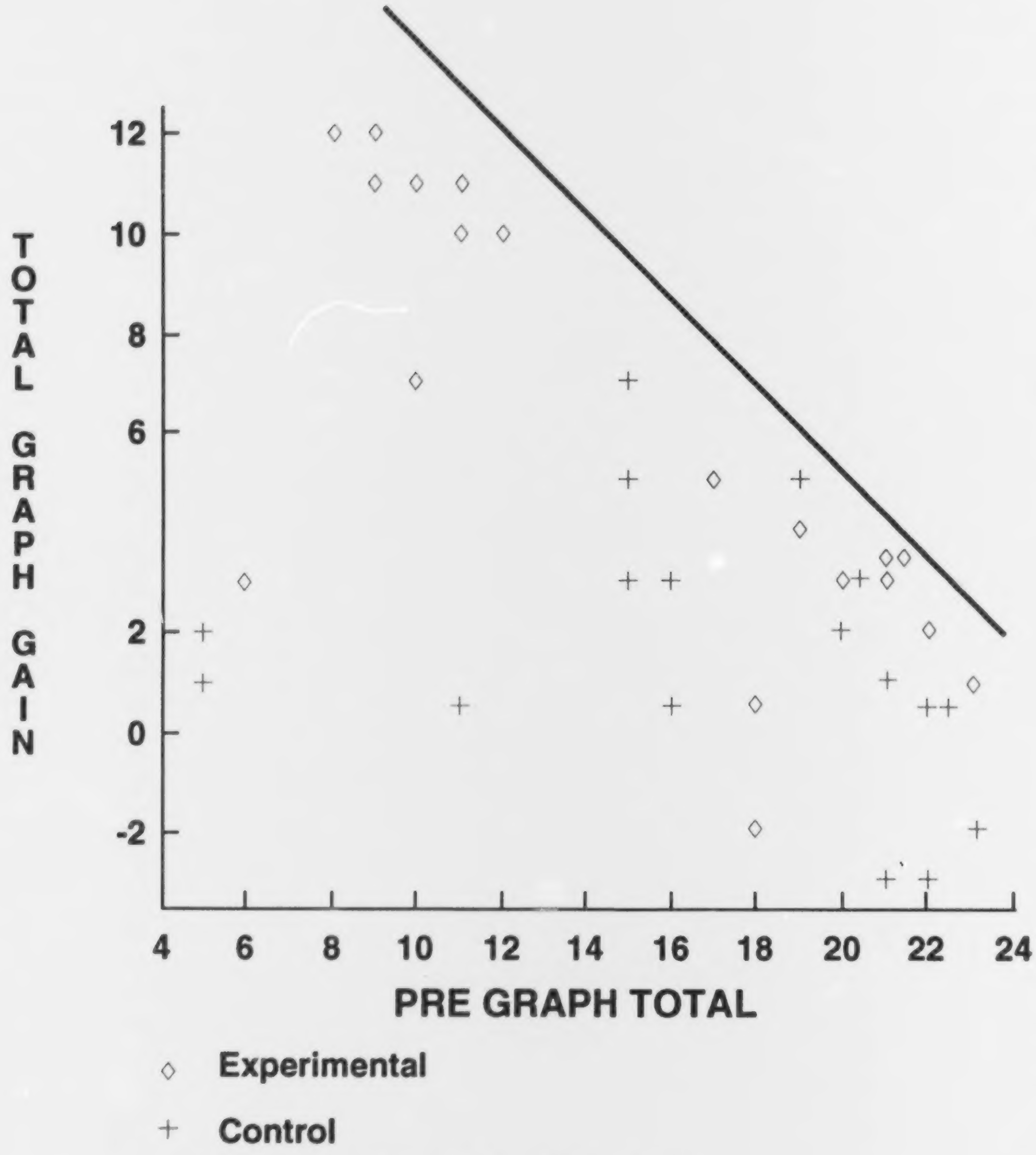
Statistic	Experimental (n = 19)	Control (n = 18)	CG-EG Difference[a]
Pretest Mean	15.05	17.17	2.12
Posttest Mean	20.79	18.67	-2.12
Gain (Post - Pre)[b]	5.74	1.50	-4.24

[a] CG = control group, EG = experimental group
[b] p=.002 (t -test, df = 35)
Note: Maximum Score = 24



EG SV 3 mean gain = 5.74
CG SV 3 mean gain = 1.50

Figure 1. Scattergram #1.



EG Mean total graphs gain = 5.74
CG Mean total graphs gain = 1.50

Figure 2. Scattergram #2.

by the end of the experiment. The position of the experimental group (represented by diamonds) closer to this diagonal perfection line is quite obvious in Scattergram #1. Two other visual aspects of this scattergram are worth mentioning. One is that the number of members of the experimental group scoring 12 or fewer points on the pretest is three times greater than the number of members of the control group. The majority of the control group pretested at 15 or more points out of the possible 24 points. The second aspect concerns the greater number of 'stragglers' in the control group at the time of posttesting. By 'stragglers', we mean students hovering away from the diagonal line of perfection. The statistical results summarized in Table 1 support the visual representation of Scattergram #1.

The experimental group started with a mean more than two points lower than that of the control group. However, the same group posttested more than two points higher than the control group. The gain of nearly 6 points by the experimental group is significant at the .002 level.

As a second example, consider Spatial Visualization 3 covering parabolas (Table 2). Scattergram 2 (Figure 2) supports these statistics. The two groups are well matched at the time of pretesting with 15 members from each group scoring 4 or fewer points. However, the gain of the experimental group is twice that of the control group. This is quite obvious in the scattergram as the experimental group dominates the area close to the diagonal perfection line, whereas the 'straggler' territory is dominated by the control group.

Table 2
Statistics for Spatial Visualization 3

Statistic	Experimental (n = 19)	Control (n = 18)	CG-EG Difference
Pretest Mean	3.11	2.50	-0.61
Posttest Mean	8.47	5.17	-3.30
Gain (Post - Pre)[b]	5.36	2.67	-2.69

[a] CG = control group, EG = experimental group
[b] p=.005, t -test, df = 35
Note: Maximum Score for Spatial Visualization 3 = 11

There were 15 tests and 4 aggregated test combinations analyzed, rendering 19 test results for examination. The pre- and posttest scores were compared as well as the gains made by each group in each test. The following summary indicates how the groups compared in each of the testing situations. For example, in two of the pretests (Graphs 1 and Spatial Visualization 3), the Experimental Group had a higher mean than the Control Group. However, in the remaining 17 pretests, the Control Group showed higher pretest scores. The t-test statistics support the conclusion that the "positive momentum" in both the level of understanding and spatial skills exhibited by the Experimental Group throughout the research period was not experienced by the Control Group.

Pretests—Experimental Group Mean > Control Group Mean (2 comparisons)
- Graphs 1
- Spatial Visualization 3

Pretests—Experimental Group Mean < Control Group Mean (17 comparisons)
- Card Rotation
- Paper Folding
- Chelsea Algebra 1, 2, 3, 4, Total
- Chelsea Graphs 2, 3, Total
- Level of Understanding 1, 2, 3, Total
- Spatial Visualization 1, 2, Total

Posttests-Experimental Group Mean > Control Group Mean (13 comparisons)
- Card Rotation
- Paper Folding
- Chelsea Algebra 4
- Chelsea Graphs 1, 2, 3, Total
- Level of Understanding 2, 3, Total
- Spatial Visualization 1, 3, Total

Posttests-Experimental Group Mean < Control Group Mean (6 comparisons)
- Chelsea Algebra 1, 2, 3, Total
- Level of Understanding 1
- Spatial Visualization 2

Experimental Group Gain > Control Group Gain (16 comparisons)
- Card Rotation
- Paper Folding
- Chelsea Algebra 1, 2, 4, Total
- Chelsea Graphs 2 3, Total
- Level of Understanding 1, 2, 3, Total
- Spatial Visualization 1, 3, Total

Experimental Group Gain < Control Group Gain (3 comparisons)
- Chelsea Algebra 3
- Chelsea Graphs 1
- Spatial Visualization 2

Test Gains Showing Significance (*t*-test, 10 comparisons)

- Card Rotation
- Paper Folding
- Chelsea Graphs 2, 3, Total
- Level of Understanding 1, Total
- Spatial Visualization 1, 3, Total

The scattergram data analysis and statistical analysis support the conclusion that the graphing calculator does have a positive and significant influence on the performance of female students in elementary college algebra. Spatial visualization skills improve along with the level of understanding. The graphing calculator's visual representation of the mathematical concepts is important as both a heuristic and pedagogic tool, particularly for those weaker students in the concrete-operational or early formal-operational level of cognitive development. Through this use of visual, multiple self-paced explorations, students are able to use concrete imagery to move toward higher levels of understanding and abstraction. Mathematical knowledge is a product of conscious reflection; the more abstract the concept, the more reflection is needed. The study indicates that it is possible through the use of the graphing calculator to create an interactive learning environment in which students are more likely to construct their own mathematical understanding through conscious reflection. The normally passive student becomes actively involved in the discovery and understanding process. Students no longer view mathematics as receiving and remembering algorithms and methods of solution.

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Geometry in game settings

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The teaching of geometry is undergoing significant change. There are two apparent causes of this change: (a) recommendations by the National Council of Teachers of Mathematics (NCTM, 1989) and (b) development of computer applications which greatly ease the difficulties of constructing geometric figures. NCTM presents a view of geometry that is somewhat different from the traditional role for this content in textbooks or state curriculum guides. In particular, there is more emphasis on development of spatial visualization skills, and students are expected to solve problems that involve mental manipulation of visual information. Computer tools ease instruction and provide "reality" and motivation for students. In fact, Lesh and Lamon (1992, p. 39) suggest that computer environments are at least as real for many students as "real-world" applications.

Although geometry is a subject that can be embedded in a variety of real world contexts, it can also be embedded in games, which seem to have unique value for keeping students engaged. Combining the motivational characteristics of computers and games, then, may prove to be exceptionally effective, at least in part because computer graphics can change repeatedly during play of a game, while displays in printed materials are limited to the images created by the developers of those materials. Computer games might be a supportive environment for development of critical visualization skills.

This paper provides an overview of what we know about the learning engendered by manipulative and computer games. Then implications for teacher education are discussed.

Manipulative Instructional Games

The largest body of instructional, non-computer geometry games is Bright, Harvey, and Wheeler (1985). Their research included three different geometry games designed to help students develop understanding at the comprehension and analysis levels of Bloom's cognitive taxonomy (Bloom, 1956). The understanding of geometry learning resulting from these investigations laid the groundwork for later study of computer games.

Bright et al. studied two games at the comprehension level. One game was used after instruction designed to produce mastery of the content (post-instructional level) and dealt with estimation of lengths and angles. The other game was used prior to instruction designed to produce mastery (pre-instructional level) and dealt with recognizing the faces of three dimensional solids. For both games, performance improved not only for tests at the comprehension level but also for tests at lower levels.

One game, at the analysis level, was used with students in grade 10 at the co-instructional level (i.e., along with instruction designed to produce mastery of the content) and the post-instructional level. This game dealt with making lists of properties common to sets of figures. At the post-instructional level, students' scores did not improve on the test of analysis level items; however, at a lower taxonomic level scores did improve. At the co-instructional level, scores on the analysis level test did improve significantly for the experimental group but not for the control group. However, a comparison of the two groups did not reveal any differences for either the analysis level test or the lower level test.

Overall, these studies suggest that games can be effective tools for improving geometry and spatial performance. However, the mechanisms by which this improvement occurs seems to be complex. Merely providing opportunities to learn, especially at the higher taxonomic levels, is not adequate.

Computer Games

The game dealing with estimation of lengths and angles was translated into a computer version (Kraus, 1982). For preservice teachers, changes in performance in the computer environment did not parallel changes noted in the non-computer version (Bright 1985 - a, 1985 - b). The computer version seemed less effective for teaching length estimation, perhaps because of the built-in distortion of vertical and horizontal lengths on a computer screen. This suggests that translations of non-computer instruction to computer environments may not result in similar instructional effectiveness.

The results also raised concerns about differences in the processes that subjects might be using in manipulative and computer versions of the games. Bright (1988 - a, 1988 - b) investigated these processes with fourth and sixth graders and observed differences, although no differences in performance were observed. As expected, differences were noted on behaviors tied to specific rules that were different in the two versions, but students using the computer version also spent markedly more time on task than students using the non-computer version.

These studies provide insight into the fact that students interpret information differently in computer and non-computer environments. This observation raises the issue of whether computer games that take full advantage of computing power (e.g., TETRIS) might be effective at teaching geometry skills that might not be teachable in non-computer formats.

Video Games

TETRIS is a video game which allows players to explore the relationships among shapes. It is a conceptual game, with components of both visualization and orientation. That is, the game requires mental operations of visual images, involving both images of completed game boards and rearrangements of the playing pieces within those game boards.

Spatial learning proceeds at two different levels: perceptual and conceptual. Generally, perception refers to a situation where the senses gather static information from the environment and transmit that information to the brain, analogous to a camera taking a picture. Perceptions, however, are not simply transmission of a copy of an object; instead, perceptions of static space are constructed. Development of perception seems to require the organization and coordination of the sensory information of prior experiences which have been coded and stored along with the activity involved in gathering that information (Lesh & Mierkiewicz, 1978). Conceptions, unlike perceptions, do not involve static ideas but rather mental operations which consist of transforming what is observed (Montangero & Smock, 1976). Representations of transformations are possible only when conceptual development interacts with the perceptual image (Montangero, 1976). Clear progress in representing transformations can be found around 7 years of age. Generally speaking, learning spatial concepts seems strongly related to attempts at representing spatial transformations.

Spatial ability is a cognitive skill which involves both perception of spatial relationships and manipulation of visual material mentally (Connor & Serbin, 1985). There are two distinct factors of spatial abilities: orientation and visualization. A figure must be perceived as a whole in spatial orientation but must be mentally restructured into components for manipulation in spatial visualization. Spatial orientation tasks rotate or translate the entire object. These activities require that a person see that the pattern arrangement of a structure is maintained even though the direction or angle of inspection has been changed. A visualization task requires an understanding of how the parts of a structure can change position in relation to each other and yet not violate the way the pattern connects. A classic example is the visualized paper folding task in which a person must anticipate what a pattern will look like when it is folded.

With regard to transformational geometry, Moyer (1978) questioned whether understanding of two-dimensional isometries is dependent on an explicit awareness of the physical motion related to a given transformation. He concluded that from a mathematical point of view, motion need not be involved, but cognitively it may be essential for the development of the concept. Kelly (1989/90) found, however, that the feedback characteristic of software for teaching transformational geometry seemed more important than the motion characteristic. In TETRIS feedback is much less explicit than in the software Kelly used. In TETRIS students must learn to interpret the visual display within quite rigid time constraints.

Description of TETRIS

TETRIS is a puzzle video game in which different geometrically shaped game blocks fall down, one after the other into a 10 x 20 unit game field. The shape of the block that falls is randomly selected by the computer. Each block is formed from four small squares (i.e., tetrominoes), analogous to the well known pentominoes. The shapes can be identified as 4-bar, 4-square, L, reverse L, T, Z, and reverse Z.

The object of the game is to keep the blocks from piling up to the top of the game field. To do this, one can (a) translate a playing block left or right and (b) rotate it as it falls. As horizontal lines are filled, those lines are erased from the playing field and points are awarded. Play continues until the blocks pile up to the top of the game field.

At all times during the game two playing blocks are visible: the one that is currently in play and the one that will appear next at the top of the playing field. To become expert, one must visualize the placement of the current playing block in order to plan for the placement of the next block. As players plan the placement of both the current piece moving down on the screen and the piece which will appear next at the top of the screen, changes in the board must be mentally constructed for various placements of the pieces (i.e., visualization). Since there is not time to generate physically all possible transformations on a piece falling down the screen, players need to generate at least some of those transformation mentally in order to use their time efficiently (i.e., orientation). Mental imaging of the playing field with the current playing block positioned is necessary in order to "plan ahead" for the placement of the next block (i.e., spatial visualization). Thus, TETRIS requires the development of a metacognitive skill, "planning ahead," as well as both spatial orientation and spatial visualization skills. Since there are a several different shapes for the playing pieces, players' differential skill at orienting these various shapes might differentially affect their planning ahead skills for these shapes.

Research Results about TETRIS

Generally speaking, the results of interviews of children playing this game (Bright, Usnick, & Williams, 1992; Williams & Bright, 1991) indicate that some children do organize their visual thinking during play of the game, though it is not clear whether most children do. Some children also use verbal cues (i.e., names of real-world objects, like chair, for different orientations of pieces) to help them organize cognition, but small samples prevent a generalization about this behavior. During continued play, students often appear to select a position for the playing block, rotate and translate the piece so that it would fit into that position, and then rotate the piece again through a complete 360 degree turn. As a piece is rotated, students seem to observe other openings in the lower portion of the playing field, occasionally reevaluate their original decisions, and move the piece to a new position. Students appear to be utilizing both figural and operational reasoning in this process. In one particular case (Williams & Bright, 1991) the six-year-old subject never performed this ritual with the bar or square blocks and only occasionally with the Z or reverse Z blocks; but he regularly did so with the L, reverse L, and T blocks. Older subjects (Bright et al., 1992) rotated the L and reverse L much more than other pieces.

Quantitative studies with older students (McCoy & Braswell, 1991, 1992) have attempted to determine if performance measures (e.g., number of transformations performed on pieces, card rotations test) would reveal differences by gender or experience. Among novice players, there were no gender differences with respect to the kinds of transformations applied to the playing pieces during play of the game. However, pretest/posttest comparisons of performance on spatial visualization tests did show improvement in scores after four weeks of practice with the game.

There is evidence across all the studies cited that players of different ages not only explicitly recognize "planning ahead" as important but also attempt to incorporate into their play. It is not known whether transfer occurs from this environment to other problem solving tasks, but at least there are preliminary indications that TETRIS might make the teaching of planning ahead possible.

Implications for Teacher Education

First, there are many areas of the mathematics curriculum for which we have real-world and computer environments which teachers can select to use to teach content; for example, (a) geoboards versus computer simulations of geoboards in which points on a grid can be connected and (b) compass and straightedge for constructions versus computer drawing tools. Presumably, the computer environments are generally somewhat more abstract. Teacher educators need to help preservice and inservice teachers deal with the decision making required to choose learning environments at appropriate levels of abstraction. Having increasingly abstract environments from which to choose is reminiscent of Bruner's (1960) view of concrete, iconic, and symbolic development of ideas, though it is not clear how good the match is between these analogous conceptualizations. The study of geometry learning across settings will help to reveal principles for instruction that could be tested in other parallel areas; for example, algebra tiles versus demonstrations of algebra tiles versus computer simulations of algebra tiles.

The results of studies of manipulative games, their computer translations, and video games also have important implications for the possible transfer of video game learning to school settings. Players seem to need actual manipulation of objects or of images of objects to support their thinking about orientation. One would, therefore, not expect school instruction to be successful unless it too provided that support for thinking. Without that support, students might be reluctant to experiment with orientation skills or to apply what they learned in the video game setting to school tasks. Coordinating non-computer with computer experiences may be one way to help students learn to connect their geometric learning across instructional environments. Teacher education programs need to help preservice and inservice teachers learn to help students make these connections.

Second, teacher educators need to know how learning is different in different environments so they can help preservice and inservice teachers understand the effects of environment. That is, what concepts of geometry do students learn in a manipulative environment that they don't learn in a computer environment (and vice versa)? How does the environment restrict what students can learn, and how can teachers help students overcome these restrictions?

In TETRIS, for example, there is a built-in time factor. Players are rewarded for their ability to plan ahead in the placement of pieces. Since time is not nearly as critical a factor in traditional school settings, looking ahead does not seem to be a skill that is rewarded much in school instruction. That is, in school students usually have sufficient time both to consider many different options for solving a problem and to explore at least several of those options. Real life, on the other hand, often involves situations in which there is not adequate time to identify multiple options or explore all options. Looking ahead, then, might be better developed in students who have sophisticated "street skills" than in students who are more "protected" from having to deal with survival in the real world. Teacher educators might be able to help preservice and inservice teachers use this characteristic of TETRIS to improve metacognitive performance of students.

Too, students' tendencies in TETRIS to rotate a figure through a complete 360 degree turn, even after a decision on where to place the block suggests that they utilize both figural and operational reasoning during play. Students appear to be unsure of their mental visualization skills and used actual rotations to validate their thinking. That is, players took advantage of the environment to support their learning. If this is a consistent pattern across ages, then this would seem to be important information for teacher educators to communicate to preservice and inservice teachers.

Third, teacher educators need to know how teaching strategies change as the environment for supporting learning changes. What kinds of questions should teachers ask when manipulatives are used versus when computers are used? Should the questions be dictated by the differences in the ways that students organize their geometric knowledge in the different environments? Most of the implications of learning environment for teaching are unknown, so it is important to begin to plan a research agenda to find out.

Interaction with geometry ideas can be supported in a wide variety of computer contexts. The use of repetition in constantly changing environments seems to challenge students to adjust their thinking in response to rapidly changing circumstances. Too, computer games seem to call on students to internalize information somewhat differently that non-computer games. Additional studies are needed that will clarify the ways that players organize, and reorganize, their geometric knowledge as they interact with these environments. Further, we need to know what transfer there might be from these environments to standard school mathematics tasks or to informal, real-world geometry tasks. The task for teacher educators is to alert preservice and inservice teachers to the differences in learning associated with different learning environments so that geometry learning can be optimized.

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TELECOMMUNICATIONS

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The major telecomputing story for academic institutions continues to be the explosive growth of the Internet. In 1991 Congress passed the High Performance Computing and Communications Act authorizing the National Research and Education Network (NREN). Senator Albert Gore, sponsor of the act, suggested that the Internet, bolstered by the NREN, could revolutionize public school education:

> This network could revolutionize public school education as well, giving teachers new tools and new ways to inspire their students. Today, hundreds of elementary and secondary schools are linked to the NSFNET, enabling students to exchange messages with other students throughout the country, and enabling teachers to share new teaching ideas with one another. (Gore, 1991, p. 16)

In 1992 the Internet Society was formed. It is instructive to compare the number of host servers on several networks according to *Internet Society News* (1992, p. 27).

Table 1
Number of hosts on some networks.

BITNET	3,477
FidoNet	16,303
UUCP	14,805
The Internet	992,000
Enterprise IP	600,000

The expanding Internet exceeds any other academic network by an order of magnitude, and it is notable that the number of private networks which utilize the Internet Protocol (the Enterprise IP networks listed) are rapidly growing as well. Many networks which are not directly connected to the Internet are developing gateways which at least permit exchange of electronic mail between systems.

The range of Internet services and capabilities is also rapidly expanding. The development and growth of Campus Wide Information Systems (CWIS) and Wide Area Information Servers (WAIS) on the Internet is illustrative of this trend.

The Internet

The growth of the Internet is affecting all academic disciplines. The Society for Technology and Teacher Education (STATE) is a logical organization to lead exploration of the capabilities of the Internet in teacher education. For this reason, STATE is establishing an Internet server for its members. The article "Introducing the STATE Internet Server" by Bull, Kinzie, Sigmon, and

Willis provides STATE members with initial information on the STATE server, and describes how the STATE server may provide a convenient means for distributing instructional materials such as Jerry Willis' TEACH-IT modules.

Teachers and students will need information and materials on use of the Internet in K-12 education. The "Internet Express" by Lisa Bievenue describes an interactive approach to K-12 exploration of the Internet developed at the National Center for Supercomputing Applications (NCSA). Effective use of the Internet in K-12 education will also require familiarization with its capabilities through pre-service and in-service teacher education. Judi Harris describes a graduate course for K-12 educators, *Internet-Based Telecomputing*, in "An Internet-Based Graduate Telecomputing Course: Practicing What We Preach." Readers may also recognize her as the author of "Mining the Internet," a popular series of columns on K-12 use of the Internet published in *The Computing Teacher*. A paper by Anderson, Perry, and Schmidt, "Internet: An Electronic Extension of the Classroom," also describes use of the Internet in a teacher education program. This report describes the establishment of a virtual classroom created through electronic interactions between students at Mississippi State University and the University of Wisconsin at Eau Claire.

User interfaces of resources accessible through the Internet may vary, with different log-on and log-off procedures and command structures. Documentation and training materials are crucial factors affecting successful use of these networks by educators. "Telecommunication Training Materials for Teacher Education" describes one approach developed by Barron and Ivers for the Florida Information Resource Network (FIRN), a network linked to the Internet which provides access for teachers and students in Florida.

In Nebraska Nemeth has altered the network itself to provide increased support for teachers, establishing local servers which allow users to customize and assume local control and ownership of parts of a statewide network. The network which Nemeth has established provides access to the Internet, complemented by local menus which can be individually configured. This approach makes it possible to customize the system to meet educators' needs. "Grassroots Telecommunications: An Alternative Teacher Education Resource" describes the features of this network. In "Information Technology for K-12 Teachers," Edwin Smith describes a networking project under development in West Virginia, RURALNET. The intent of this project is to make Internet resources more accessible to rural educators by establishing an Internet file server for them, with educational materials and activities of particular interest for that setting.

Educational Telecomputing

There are a number of ways in which telecomputing technologies can be integrated into teacher education programs. In "KIDLINE: Electronic Fieldwork in Teacher Preparation Classes," Eskridge describes use of an electronic conferencing system in a class in children's literature. Communication with elementary students through the network provides teacher education students in this class with broader exposure to the thought processes of elementary students. A second article by Eskridge and Langer, "Electronic Conferencing: Extending Discussion Opportunities in Teacher Preparation Classes," describes ways of encouraging electronic discussions among teacher education students themselves.

A computer network developed for support of elementary education student teachers is described by Lowe in "911 for Student Teachers." A similar effort addressing the needs of student teachers in special education is described by Yan, Poage, Munson, and Anderson in "The Integration of Telecommunications into Special Education Student Training." Thompson and Hayes describe the use of telecomputing to address the transition from student teaching to the first year in the classroom in "Patterns of Use of an Electronic Communication Network for Student Teachers and First Year Teachers."

The focus of Project INSITE, described in Rush's article, "Breaking Down Barriers through Telecommunications," addresses in-service teacher education and classroom use of telecomputing networks. This project, supported through the National Science Foundation, assists teachers in creating student projects which focus on real-world issues, providing electronic links to scientists, on-line databases, and other students. Stapleton also describes ways in which teacher support and education can be provided through telecomputing networks in "Distributed Schooling: A Model for Computer Network-Supported Teacher Education."

Integrated Systems Digital Networks

For many years Integrated Systems Digital Network (ISDN) technology has offered the promise of transferring synchronized video and audio signals and computer data through telephone lines. Although the long-term future of this technology may ultimately depend upon the rate structures offered by commercial vendors, the promise is becoming a reality in some areas. Nikki Davis describes use of ISDN technology for support of teacher education in the United Kingdom in "Multimedia Teaching at a Distance: Emerging Issues of Computer-Supported Cooperative Work in Education and Training." Synchronization delays still present problems, but the overall results appear to be encouraging.

A series of three articles by Blanton and Thompson,

Thompson and Blanton, and Zimmerman and Blanton describe another ISDN experiment established through a partnership among Appalachian State University, AT&T, Bell South, and Southern Bell. This project, titled XCLINIC, also addresses support of clinical teaching. The first article, "Application of Telecommunications to Clinical Teaching Experiences," describes the network and its integration into the student teaching process. The second article, "Evaluation Research on Telecommunication Applications in Teacher Education," outlines the research design developed for evaluation of use of the network. The third article, "Invitations to Shared Thinking: Using Telecommunications in Teacher Education Programs," describes use of electronic mail by second and third-year teacher education students serving as tutors for academically at-risk students in the schools.

Evolving Distance Learning Technologies

The evolution of educational technologies continues to offer an increasing range of options at a decreasing cost. The selection of the mix of technologies for a particular situation depends upon individual circumstances and the available budget.

"The Appalachian Distance Learning Project," described by Flemister, Sexton, and Beach, is a collaborative effort established through partnerships among Ohio University, local school districts, and Ohio Bell and GTE. A fiber optic system permits transmission of full-motion video among participating schools and the College of Education. In contrast, compressed video is the technology employed by Austin for delivery of a course in Wyoming. Considerations affecting delivery of a course by these means are described in "Designing a Technology Course to Be Delivered via Interactive Compressed Video." Scanned images delivered via phone (audiographics) is a third technology. Knapczyk, Brush, and Rodes describe delivery of continuing education courses through this format in "Continuing Teacher Education at a Distance Using Audiographic Technology."

Saba suggests that as integrated voice, video, and computer data systems are increasingly employed in future distance education efforts, it will be necessary to develop methods for training instructional designers and teachers in the use of these systems. Such a course is described in "Training Distance Educators for Converging Technologies." Finally, Knott addresses the issue of evaluating the efficacy of distance education efforts in "The Teacher's Role in Evaluating Distance Education."

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Introducing the Society for Technology and Teacher Education (STATE) Internet server

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The Internet, the world's largest wide area network, is altering the landscape of academic and scholarly work. The Internet is actually a network of networks. There are currently several thousand networks which collectively comprise the Internet. Each of these individual networks, in turn, is comprised of a number of host computers. The Internet has grown from the original four host computers of the initial ARPANET in 1969 to an estimated 992,000 servers in September 1992. (Press, 1992, 21) The rate of growth is currently estimated to be approximately a thousand Internet servers per day. It has become the *de facto* academic network for higher education, and is rapidly spreading to the public schools in many states as well.

Just prior to establishment of the Internet, Licklider and Taylor (who played key roles in creation of the ARPANET) outlined a vision of a world-wide academic network:

> What will on-line interactive communities be like? In most fields they will consist of geographically separated members, sometimes grouped in small clusters and sometimes working individually. They will be communities not of common location, but of common interest. (Licklider and Taylor, 1968, p. 30)

The explosive growth of the Internet suggests that this vision is rapidly becoming a reality.

A society devoted to technology and teacher education would seem to be a logical candidate to lead the way in exploration of these capabilities in the field of teacher education. Accordingly the Society for Technology and Teacher Education has established an Internet information server. In this article introducing the STATE server, we will provide information on how members of the Society for Technology and Teacher Education can access the STATE server, provide an overview of features of the STATE server, and discuss in detail instructional resources known as TEACH-IT modules available on the STATE server.

The STATE Internet Server

The STATE server is physically located at the University of Virginia, and resides on an IBM RS-6000 Unix workstation donated by IBM for this purpose. The software developed to implement the STATE server was adapted from applications developed for the Virginia Public Education Network (PEN), an educational telecomputing network linking Virginia's public schools to the Internet.

Timothy M. Sigmon, associate director of Academic Computing at the University of Virginia, is the architect of the software used to implement these systems. An experimental server running the same software has also been established in England. Niki Davis, education professor at the University of Exeter and current chairperson of the UK Association for Information Technology in Teacher Education, has christened this suite of programs as the Telecommunications Management Software (TMS) information system in honor of its developer.

Accessing the STATE Server

The STATE server is accessed via telnet. The ability to telnet to another computer allows the user to access a remote host just as though it were on the local area network (LAN) of the user's home campus. If you are already linked to the Internet and are using telnet this will be a straightforward process. If you have not used telnet before, you may need to contact your university's academic computing center. Details of the methodology may vary somewhat from institution to institution, but the general procedure for logging onto the STATE server is as follows:

```
telnet state.virginia.edu
```

When you access the STATE server, enter "state" in response to the "Login" query. First-time users should enter "guest" in response to the "User ID" query. (It is important to enter this information exactly as shown below, in lower case).

```
Login:      state
User ID:    guest
```

The "terminal type" query requires an explanation. Prior to the advent of personal computers, desktop terminals (consisting of a keyboard and a monitor) provided the chief means of connecting to a remote timeshared host computer. As microcomputers gradually became popular, the telecommunications software developed for them emulated existing terminal characteristics. The DEC VT100 terminal was a widely used terminal which became a de facto terminal emulation standard in microcomputer telecommunications software.

In most cases your telecommunications software will support VT100 terminal emulation. In that case, simply press the <RETURN> key to accept "vt100" as the default terminal emulation in response to the "terminal type" query. (In the rare instance of telecommunications software which does not support VT100 terminal emulation, enter a question mark "?" for a list of other supported terminal emulation types.)

```
Enter terminal type [default is vt100]:_
```

First-time users of the STATE server are requested to complete a short electronic form which requests information such as:

```
Name:
Institution:
Address:
City:
State:
ZIP:
Phone:
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You will also be asked to choose a user ID and a password for yourself. The User ID can be any combination of letters which does not contain a space. Therefore "JohnDoe" or "John_Doe" would be acceptable user ID combinations, but "John Doe" would not (because it contains a space). A good password should contain at least one non-alphabetic character. Thus "charge;ahead" or "my8univ" would be good passwords, but "instruct" would not be. (Inclusion of a non-alphabetic character makes it more difficult for password detection programs to crack the password.) A good password should also be non-obvious (to others) but easy for you to remember.

Use this User ID and password the next time you access the STATE server:

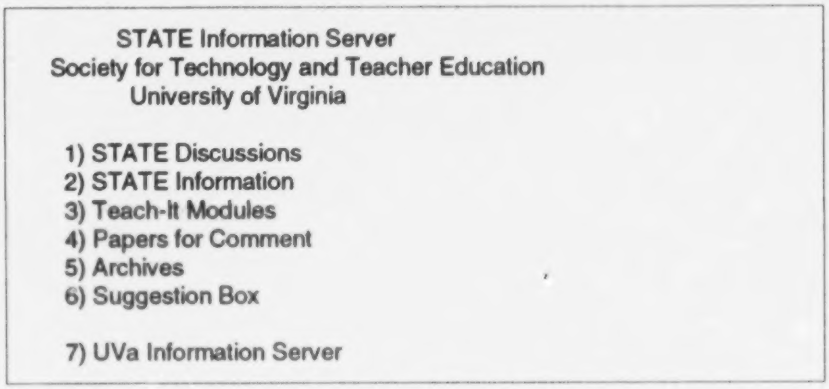
```
Login:      state
User ID:    JohnDoe
Password:   my8univ
```

Features of the STATE Server

The STATE server is a prototype system. Therefore the appearance of the menus may have changed by the time you log on. It is particularly likely that enhancements and software currently being tested on Virginia's Public Education Network will be incorporated into the STATE server within the next year. However, the general concepts outlined below will hold true, even though enhanced features may alter the menus.

The opening menu at the time this is written contains six categories of STATE information. It is likely that the mix of categories on this menu will change in response to feedback as the server is used by STATE members.

The first item, STATE discussions, is a discussion group (more formally known as a "newsgroup") which provides a forum for discussions of issues related to technology and teacher education. The second item, STATE information, is intended for postings of information which do not require interactive discussion. The menu items for "Teach-It Modules," "Papers for Comment," and "Archives" are all intended for postings of documents and/or software which may be of interest to STATE members. The suggestion box provides a convenient way to provide feedback about the STATE server or to submit an item or document for possible posting on this



STATE Information Server
Society for Technology and Teacher Education
University of Virginia

1) STATE Discussions
2) STATE Information
3) Teach-It Modules
4) Papers for Comment
5) Archives
6) Suggestion Box

7) UVa Information Server

Figure 1. The opening menu of the STATE server.

information system.

The success or usefulness of an information system depends as much upon the social structure which supports it as its technical capabilities. There are numerous instances of electronic bulletin boards and information systems which have languished in the absence of useful content.

Activities on the STATE server will be overseen by a "curator." The concept of "curator" has been borrowed from the Virginia Public Education Network (PEN), and consists of a facilitator who encourages users to actively contribute and participate in activities on the server. The curator for the STATE server will be supported by a group of advisors who constitute a "Board of Governors." This group consists of faculty and scholars in the field of technology and teacher education who have active experience in developing and supporting educational networks.

Instructional Modules on the STATE Server

At its most effective, an electronic information system complements rather than replaces traditional print media. To provide a sense of how this might work, we are going to describe one on-going experiment, TEACH-IT modules, in detail. Jerry Willis developed the concept of STATE TEACH-IT modules to promote dissemination of instructional modules related to technology and teacher education. (Willis, 1992) TEACH-IT modules have the novel characteristic of appearing both in print format and in a parallel electronic version available through the Internet on the STATE server.

Each year the Society for Technology and Teacher Education hopes to publish a monograph containing a dozen instructional modules contributed by its members. Faculty who purchase the monograph will also receive permission to make copies of any of the modules for their classes. This will make it economically feasible for faculty members who only need two or three of the dozen modules to employ them in their classes. Publication in an edited monograph provides faculty with an incentive to contribute to this effort, ensuring that they receive academic credit in the tenure and promotion process.

Electronic versions of each TEACH-IT module will also appear on the STATE server. This parallel method of dissemination will yield benefits which cannot be achieved through either electronic or traditional publication alone. In this section on instructional modules, we will discuss limitations of electronic publication, limitations of traditional print media, and the role of TEACH-IT modules in resolving this dilemma.

Limitations of Electronic Publication

Almost every faculty member who teaches courses with educational technology content has developed instructional modules at one time or another. These modules address areas ranging from desktop publishing to networked databases. With well over a thousand teacher education programs, there is no reason why individual faculty members at each institution should develop modules for every area of educational technology.

The field of teacher education would benefit from provision of one or two of the best examples in each area. The barriers which prevent this from occurring are institutional rather than technical. It would be simple enough to establish an FTP archive on the Internet for instructional modules. (The Internet File Transfer Protocol, usually abbreviated "FTP," allows files to be transferred from one computer to another over the Internet.) There are several reasons why this approach may not be sufficient by itself.

- Academic credit for electronically published documents is not yet a reality.

Although some institutions have begun to recognize non-print media in the tenure and promotion process, many do not. Even those institutions which have begun to acknowledge alternative media may not give such efforts the full weight offered for refereed print publications.

As long as this state of affairs is a reality, faculty are best advised to focus their efforts in areas which will be rewarded.

- Electronic archives often are contaminated by the wide variability in the materials available.

  There are thousands of FTP sites on the Internet, and thousands more USENET Newsgroups. The process of filtering information available presents a problem. If the quality of information in an archive is variable, it may seem easier to develop materials independently rather than sift through existing materials.

- Some of those in greatest need of these instructional materials may not yet routinely use the Internet.

Although electronic materials are evolving rapidly, print will remain an important dissemination channel for many years to come.

Limitations of Print Media

Traditional publication and dissemination of instructional materials through print media also has certain limitations. One limitation associated with publication of any instructional module in the field of educational technology is a tension between specificity and generality. Students who use these materials benefit from instructions that are specific. If they are using Microsoft Works for DOS on a PC they want instructions for that software. If they are using WriteNow for the Macintosh they want directions for that program. However, in a market in which students in different courses at different universities use different programs, any module published for national and international distribution will not meet the specific needs of all users.

Creating many versions of the module presents problems for the developer and the distribution channel. Creating one version, on the other hand, means it will serve some situations well and others poorly. Creating a generic version simplifies development and distribution, but can decrease the effectiveness of the materials. The instructional designer is faced with one of three less than satisfactory choices:

1. describe the process in generic terms, without mentioning a specific application or environment,

2. describe a specific application and environment in detail, which makes the description less useful to those who use a different application, or

3. describe the process for several different applications, which becomes cumbersome for readers to follow (not to mention the problems posed for the developer)

Resolving the Dilemma: TEACH-IT Modules

TEACH-IT modules provide a means of addressing this dilemma. Their publication in print format provides two very specific advantages:

1. Because the materials have been submitted to editorial review, and appear in print format, there is no ambiguity about whether they may be utilized in the academic promotion process.

   This provides developers with an incentive to publish materials which might otherwise have remained in their original class notes format.

2. Publication in print format also may be convenient for instructors who do not wish to customize materials.

Not everyone will want to customize materials for their classes. A print version will allow these instructors to copy and use the materials just as they appear in print.

The simultaneous appearance of TEACH-IT modules in electronic format, on the STATE server, offers several additional advantages.

1. Provision of TEACH-IT modules in electronic format allows instructors to download the file and customize the materials to meet the needs of the classes they teach.

   For example, a TEACH-IT module that introduces students to use of HyperCard for development of electronic presentations is available on the STATE server in a PageMaker file. Instructors can download the file and then edit it as needed to fit the course they teach. Additional instructions about where the local computers with HyperCard are located could be added. Or, specific assignments in the module could be adjusted to coincide with other course objectives. This TEACH-IT module also contains a HyperCard template which can be used in conjunction with the print materials. Electronic access to instructional modules provides instructors with the advantages of textbooks - peer evaluation and completion of a standard editorial process, while also providing the benefits of instructor-developed software - low cost to students and the potential for customization by the instructor.

2. The STATE server also provides a convenient means of updating modules.

   Software is volatile. HyperCard Version 1.0 quickly becomes HyperCard Version 2.0 which in turn becomes Version 2.1. Instructional modules which contain specific references to software have an equally short shelf life. It is not economically feasible to issue a print revision each time software changes. However, the developer who intends to revise an instructional module for his or her own class can just as easily post the update on the STATE server as well.

3. The STATE server also provides a convenient way to offer associated files and examples.

   Since developers first began creating instructional modules on use of BASIC, the issue of how to incorporate examples into the text has been a perplexing one. Often these examples incorporate short subroutines and listings into the text, and place longer listings at the end as appendices. However, typographical errors as listings were entered were common sources of frustration. Newer genres of graphical software such as HyperCard and MacroMind Director compound the problem. A disk inserted into the book provides one solution, but adds to the cost and complexity of publishing the manuscript. The STATE server will allow developers to develop TEACH-IT modules with the knowledge that they can incorporate files and other electronic materials into the design of the module.

At one time it was thought that electronic media might displace print media. However, TEACH-IT modules in the form of a printed monograph and their electronic counterparts on the STATE server have the potential to complement one another. The printed version and review process guarantees developers that there is no ambiguity about academic credit and assures users that the quality of the modules meets acceptable standards. The electronic version allows instructors to customize modules, provides a convenient means of posting updates, and allows associated files and examples to be provided.

Long-Term Instructional Effects

In the long term the STATE server has the potential to have an even broader impact on technology and teacher education. Widespread dissemination of instructional modules from different institutions could potentially result in a cross-fertilization and exchange of ideas which otherwise might not take place. Until now the academic system has tended to reduce sharing and development in this area in favor of activities that fall within clearly established reward structures. By designing a marketplace that encourages development within the existing system rather than by attempting to change the overall system, instructors, students, and institutions will all benefit.

If you are interested in developing a TEACH-IT module, send a note to Jerry Willis (preferably by electronic mail at the address of jwillis@jetson.uh.edu) requesting guidelines and sample modules. Indicate the topic for which you wish to develop an instructional module.

If you have logged onto the STATE information server, and have a suggestion, use the electronic Suggestion Box to send a note to the curator. We have outlined one way in which the STATE server and TEACH-IT modules in combination may enhance the profession, but the ultimate success of this electronic system will depend upon contributions and participation by STATE members.

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The Internet Express

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The Internet

The Internet is a worldwide collection of thousands of computer networks that can intercommunicate. All of them speak the same language, namely TCP/IP (Transmission Control Protocol/ Internet Protocol). Users of any of the Internet networks can reach users on any of the other networks.

Approximately one million people use the Internet daily. Since its creation in 1983, the number of networks connected to the Internet has grown exponentially. By 1985, the number was approximately one hundred. By 1987, the number had grown to two hundred; in 1989, it exceeded five hundred. According to tables kept at the DDN (Defense Data Net) Network Information Center (DDN NIC), there were 2,218 networks connected to the Internet as of January 1990. Recent political activities indicate that the Internet will continue to grow at this rapid rate. The Internet has already reached most institutions of higher education and more and more businesses are finding Internet connections useful and sometimes necessary to conduct business in an efficient and cost-effective manner.

The Role of the Internet in K-12 Education

K-12 educators and administrators must now recognize the value of the Internet on two levels. First, the Internet provides a wealth of resources, forums, and worldwide connectivity. The Internet can break isolation barriers by bringing the world to the classroom *and* bringing the classroom to the world (something previous technology has not been able to accomplish). Second, the Internet has so permeated society that if K-12 education supposes to prepare students for the world in which they will live and work, Internet education is a necessary facet of both pre-vocational training and pre-college education. The NCSA (National Center for Supercomputing Applications) Education Group is involved in promoting use of the Internet for educational purposes in K-12 schools. In Internet workshops and training sessions we encourage teachers to use the Internet for more than a high-tech pen pals medium. Through in-service and pre-service training we help teachers explore the Internet for science, social studies, and English resources, so that they can develop interdisciplinary lesson plans. This experience has led us to the development of an interactive and interesting method to approach learning on the Internet: The Internet Express.

The Internet Express

"The Internet Express" is a murder mystery of sorts. The murderer can be found somewhere on the Internet, i.e. in some file on some computer which is accessible through the Internet. Participants are given an initial clue by e-mail. The clue could take them anywhere on the

Internet where they can find more clues. By following the trail, participants can turn up a seemingly infinite number of resources. Locating the various databases, newsgroups, archives, and bulletin boards help the participant learn where interesting resources reside. Clues are located by using various Internet communication tools, such as FTP (file transfer protocol), telnet, e-mail, and gopher. By using these tools, participants begin to learn their way around the Internet. A well-devised "Internet Express" mystery will take participants to many diverse resources so that all participants will find something of interest and something that might become essential to their work or study.

NCSA's approach to "exploration" of the Internet is exploration in a true sense of investigation, inquiry and discovery. We have attempted to not simply list resources and point teachers and students in the right direction each time they need a new resource, but to teach them how to approach the search, much as one would teach problem solving techniques. In doing this we have taught them how to adapt to the ever-changing Internet. These teachers and students are now ready to use the Internet, and most inter-connected networks, to do research, to communicate with experts, and to solve problems.

Before taking on an "Internet Express" mystery, participants observe the use of the Internet tools that will be involved. We have found that a brief coverage of the tools and how to use them, followed by the immediate exposure to an "Internet Express" mystery, is the most efficient way to teach. With just a brief coverage of the tools, participants usually do not fully understand how to use the tools, but they do become motivated to learn once they become involved in the mystery. In other cases in which we used only demonstrations and laboratory work to teach how to use the tools, most participants tired of learning things that didn't seem important or interesting. It seems that regardless of how long we spend in the initial phase of learning how to use the tools, participants do not actually learn to use the tools until there is a reason that *they* feel the need or desire to learn how use them. In all cases, once participants began using the tools in the murder mystery, they did learn how to use the tools *and* where they could find interesting information that was useful to them.

Using the Internet Tools to Teach Problem Solving

Throughout the "Internet Express" mystery various pieces of information on how to use the Internet as a problem solving medium are discussed. For example, when discussing the use of e-mail we can discuss how to find the electronic mail address of another person without being able to ask that person directly. A "postmaster" at the recipient's organization can provide the correct address when the domain name of the organization is known; one can send a message requesting help to <postmaster@domain>. Also, the DDN Network Information Center (DDN NIC) in Menlo Park, California, maintains a "white pages" directory of computer users, hosts, and domains on the Internet. One can use Telnet to access this database on a computer called nic.ddn.mil. Many computers also have a program called whois, which automatically accesses the DDN NIC database.

Telnet and File Transfer Protocol (FTP) are used in the "Internet Express" mystery as traveling devices. Telnet is a program which allows one to communicate with other computers. To communicate with another computer simply type *telnet <host>* where <host> is the name or IP (Internet Protocol) address of the computer (e.g., mars.ncsa.uiuc.edu and 141.142.20.13 refer to the same machine). Every machine that is connected to the Internet has an IP address and each one is unique. FTP is the Internet standard protocol for moving files from one computer to another. One can use the ftp command to copy computer files containing a variety of kinds of information, such as software, documentation, or maps. FTP is the name of not only the protocol, but usually also of the program the user invokes to execute it (e.g., by typing *ftp host.bbn.com*). Anonymous FTP, like Telnet, requires access to the Internet. Unlike Telnet, anonymous FTP is widely available; anyone can become an Internet traveler by giving the command *ftp host* (e.g., ftp cs.fredonia.edu, where cs.fredonia.edu is the host). When the remote host prompts with login: and password: (or something similar - details vary on different types of computers) the traveler types "anonymous" for the login name and "guest" for the password. The UNIX command "ftp" stands for "file transfer program", whereas the acronym FTP stands for "File Transfer Protocol". When using ftp (the program) it is important that the letters are not capitalized (UNIX is case-sensitive). After logging in, the traveler remains in a program with a restricted set of commands. Files on the remote host are usually protected so that visitors cannot change or delete them.

Developing Interdisciplinary Internet Projects

By participating in a "Internet Express" mystery, students and teachers begin to learn how they can develop projects to use the Internet to focus on their interests and areas of study. There are several categories which can be used to describe activities that use the Internet, as well as many other networks. Some of these categories are interactive (real-time), electronic mail (non-real-time and private) and bulletin board-type communication (non-real-time and public). Most projects can use any of these methods and each method has a particular advantage. Interactive projects feature immediate feedback and a more informal feel. Electronic mail (e-mail) is just like sending a letter, it has the same advantages and disadvantages as real mail (although e-mail is much faster than surface mail). There tends to be a longer turn around time than interactive projects, although this facilitates more complete responses. Electronic bulletin boards invite a large number of people to discuss a topic or question. Some bulletin board or newsgroup participants may just ask questions or give an electronic nod of approval, but they may also debate a point by posting opposing views.

The particular method which a particular teacher might want to use depends on the project and the available equipment. An interactive project requires the most preparation and is the most demanding on resources. Some interactive projects are *chats*. Chat is jargon for having a mechanism in which two or more users can communicate directly. As one user types a message on a machine, that message is being sent to all the other people in the chat at the same time. To initiate a chat, one must first find a host for the chat that is available when needed and is willing to be the host, such as Cleveland Free Net. Coordinating all parties involved tends to be the most difficult part of a chat.

Electronic mail is a good method for projects that do not have time constraints. It might take as much as five to seven days to get a response with electronic mail. This allows time for delivery, reading, composing a response, and the return delivery. It does not allow for responses that need research and assumes that the recipients check their mail two to three times a week. Many schools do not have the resources or freedom to allow their classes to check their mail everyday; a prearranged schedule may help to speed up responses. Using e-mail also helps students to develop their letter writing and grammatical skills.

Bulletin boards are the middle ground between chatting and e-mail. Newsgroups are similar to bulletin boards. Newsgroups (more commonly called "net news" on the Internet) are a collection of groups that are dedicated to specific issues. For instance, a newsgroup called "rec.music.beatles" is a forum for the discussion of the Beatles and related issues. There are newsgroups for just about any topic one could imagine: alternative lifestyles, education issues, comic books, etc. When a message is sent to a bulletin board or a newsgroup, that message is sent to millions of potential readers. Any of those readers may choose to post an answer or comment to that note. You or anyone else may post a rebuttal and so on. Most postings will get an answer within a day or so. It is not unusual for more obscure topics to go unanswered or to have a controversial posting generate twenty or more responses in a single day. This method is a good way to seek advice or answers.

Chats, e-mail, and bulletin boards are three basic methods of doing network projects, but the number of possible projects is only limited by imagination. One simple use of the network is to use it as an expert resource. E-mail can be sent to college professors or a note posted to a group to get the information faster than searching for the data in all of the libraries in town. A teacher can also have students use the network as a resource for a project or just to ask questions. Several systems offer electronic question and answer services. One can also set up a mentor type program with more advanced students or even university people. The NCSA "Ask the Scientist" program is an example. In this program, elementary and middle school students send questions to advanced high school science classes using e-mail and the high school students research the questions and respond with an understandable answer. Internet is an international system, so one can use the network to communicate with people in other countries. Cultures can be compared or students in different countries can work on a project together. Some current projects using the international aspect are the Global Grocery List and Glasnet. Both of these projects are described in detail in the appendix to this chapter. Some federal and public agencies have their own bulletin boards. NASA has a board which contains a large volume of information concerning their current or past projects. The National Science Foundation also maintains a bulletin board for monitoring projects or checking on grants. Most bulletin boards are run either by educational sources or computing agencies. Cleveland Freenet and FrEdMail are examples of educationally based bulletin boards, even though these two are very different from each other. There are also bulletin boards, such as CompuServe, which are excellent software and technological information resources.

For More Assistance

The Incomplete Guide to the Internet, Especially for K-12 Teachers and Students, developed by NCSA, is meant to provide a helping hand in understanding and applying the Internet entity. It is by no means a complete guide; rather it is a general overview of what the Internet is and some of the resources available. In areas where the information presented is very general, alternate, more in-depth sources are cited, most of them available right from your computer. This guide will also provide you with ideas for using the Internet in a classroom as well as a personal environment. This guide is available in electronic and paper formats by contacting Chuck Farmer, NCSA, 152 Computing Applications Building, 605 E. Springfield Avenue, Champaign, IL 61820; ph: 217-244-6122; e-mail: cfarmer@ncsa.uiuc.edu. The guide is also available via anonymous ftp at *ftp.ncsa.uiuc.edu*.

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An Internet-based graduate telecomputing course: Practicing what we preach

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The unique characteristics of different instructional media allow the construction of uniquely configured contexts for learning. The interactive nature of exchange in text-based telecommunications, such as electronic mail and computer conferencing, implies that some of the most powerful uses of the medium are those which involve *asynchronous* interpersonal interaction. Many implementations of distance education technology, including those that involve use of telecomputing tools, attempt to transfer *synchronous* face-to-face instructional techniques directly into *asynchronous*, long-distance learning situations. As Mason & Kaye (1990) suggest, "distance education should not be the mere delivery, 'at a distance,' of classroom-based instruction. A verbatim transcript of a lecture circulated by post to students spread over the country does not constitute distance education." (p. 16) Existing instructional techniques must be adapted to fit interactive, asynchronous educational environments to work well (Levin, Kim, & Riel, 1990), and new techniques that exploit the unique characteristics of telecomputing situations must be developed (Romiszowski & de Haas, 1991; Hiltz, 1986). Before developing these techniques, goals for teaching and learning must be examined carefully to determine whether they are best met using computer-mediated communications (CMC) tools.

Let's assume that a group of educators would like to explore the resources available on the Internet, and develop ways to integrate use of these resources into primary, secondary, and post-secondary teaching and learning. What better way is there to experience and apply Internet resources than from within a primarily on-line, Internet-based teaching/learning context? Yet once the decision regarding primary instructional strategies has been made, another question emerges. How might a primarily on-line teaching/learning context be created that exploits the unique attributes of asynchronous telecomputing tools? This paper will describe one experimental response to that challenge: a graduate course, set in an asynchronous, on-line environment, designed for educators who are interested in learning to *mine the Internet* (Gargano, 1991) for instructional resources. First, though, it might be helpful to review the distinctive characteristics of CMC teaching/learning environments.

Unique Attributes of CMC

What are the characteristics associated with asynchronous telecomputing tools that suggest the types of teaching/learning contexts that they can help to create? The asynchronicity itself can assist self-directed learning through flexible scheduling; the class is available literally 24 hours a day, and students can take as much time as they need to read postings and formulate responses

(Harasim, 1990). In addition,

> CMC...can provide vastly enhanced opportunities for dialogue, debate, and conversational learning. Furthermore, it provides a real sense of community and affiliation...Contributions to a computer conferencing environment come without the visual and status-determining cues of face-to-face exchanges. This tends to produce a relatively democratic atmosphere where individual contributions are valued on their own merit. The content of the message becomes the primary focus, which can lead to an ideal situation for developing the tools of critical thinking. (Mason & Kaye, 1990, pp. 16-17)

The messages themselves form a permanent record of all that has transpired during the class. Since this record can be downloaded, commented upon within the text itself, and uploaded again to present to other students, at least one of the class' "required readings" is dynamic and collaboratively created. This is quite different from the ways in which texts are typically experienced in traditional face-to-face instruction (Mason & Kaye, 1990). On-line course participants report that these attributes of computer conferencing environments encourage increased attentiveness to content and more balanced participation among different class members (Harasim, 1990).

Writing and CMC

Writing is the primary means of both learning and teaching in an on-line environment. As Gage (1986) described it,

> Writing is thinking made tangible, thinking that can be examined because it is on the page and not in the head invisibly floating around. Writing is thinking that can be stopped and tinkered with. It is a way of holding thought still enough to examine its structure, its flaws. The road to clearer understanding of one's thoughts is traveled on paper. It is through an attempt to find words for ourselves in which to express related ideas that we often discover what we think. (cited in Harasim, 1990, p. 49)

This implies that CMC is an essentially literary experience, which requires and can help to develop analytic and verbally expressive skills. The sharpening of such skills is often primary among postsecondary learning goals (Mason & Kaye, 1990). Metacognitive skills, such as self-reflection and revision, can also be enhanced in the CMC environment because the text-based nature of the medium requires that all aspects of interaction must be made explicit (Harasim, 1990).

Cooperative Learning and Participant Roles

The unique attributes of computer-mediated communications are particularly well-suited to support cooperative learning (Hiltz, 1990; Harasim, 1990; Mason & Kaye, 1990). Although CMC can be used, like many other media, to "deliver instruction," when used as a *context* for teaching and learning, it can also support the emergence and cooperative construction of knowledge and comprehension among the members of an on-line group. This can support a dramatic transformation of the nature of the teaching/learning context, in the course of which the student moves from being a passive recipient of expert-provided information to being an active participant in the creation and comprehension of knowledge itself (Harasim, 1990; Hiltz, 1986).

Hiltz (1990) and Siegel, Dubrovsky, Kiesler, & McGuire (1986) suggest that, when compared to face-to-face classroom interaction, the more egalitarian nature of the CMC environment makes it easier for students to play what once were assumed to be teachers' roles. Seminar-style presentations and lively discussions work well in text-based computer conferences, because competition for "air time" is reduced (Romiszowski & de Haas, 1991; Harasim, 1990; Mason & Kaye, 1990). Computer conferencing may also suppress the emergence of a predominant group leader (Harasim, 1990). Yet, this egalitarian atmosphere may be short-lived; Romiszowski & de Haas (1991) state that it is evident only during the initial stages of on-line group interaction. Also, decisions that must be reached by consensus can be awkward and time-consuming to form on-line, making deadlines difficult to meet (Harasim, 1990; Siegel, et. al., 1986).

Hiltz's (1990) research on instructional CMC (or *virtual classrooms*) revealed that students who fare well in on-line learning environments are typically self-disciplined, have average or better verbal and quantitative skills, and have relatively easy access to telecommunications facilities. Romiszowski & de Haas (1991) emphasize the need for teachers using CMC tools to be active group leaders, but not in the ways that are common in face-to-face classroom situations.

> This leader or moderator must be the host, setting a congenial, non-threatening climate, thanking people for their contributions, and stimulating them to react (again). But next to this [the leader] has to be a *chairperson*, summariz[ing] the discussion, ask[ing] for clarifications, creat[ing] unity, and [keeping] the theme from drifting off track. And last but not least, the leader has to maintain the bunch of participants as a group. Group maintenance includes such duties as mediating differences that become obstructive and making comments pertaining to the group's progress." (p. 54)

This is much easier to recommend than to enact. Therefore, the challenges that are unique to on-line learning environments should be stated.

Challenges of On-line Interaction

On-line courses typically consume more of teachers' and students' time than do courses delivered with non-computer-mediated tools (Hiltz, 1990). Text-based interaction may cause participants to feel the effects of *information overload,* since the more lively the discussion, the more reading is required of each participant. The possibilities of frustration multiply as the participant group's size increases (Harasim, 1990). As Hiltz (1990) states, "for some students, the [virtual classroom] can be perceived as an imposition rather than an opportunity" (p. 169), because all group members must participate actively (rather than passively taking or reading through lecture notes), and to avoid being overwhelmed, participation must occur daily.

Although the time-shifted nature of asynchronous communication gives the learner greater control over the temporal conditions of the learning environment, participants may feel anxious after having "spoken" asynchronously when timely responses are not received. Feenberg (1987) likens this to the feeling of speaking into a vacuum. Harasim (1990) found that some students are reticent to contribute to a discussion that has a relatively permanent verbatim record. Also, physical cues that we all take for granted as non-verbal responses to our remarks in face-to-face interactions, such as facial expressions, vocal intonations, hand gestures, and subtle nuances of person-to-person interchange, such as wit and irony, are difficult to include in text-based interactions. Participants often describe this as a significant loss, which can heighten feelings of social insecurity (Romiszowski & de Haas, 1991; Harasim, 1990; Hiltz, 1990).

Timing also presents a challenge in an asynchronous environment concerning discussion theme threads. Since the entire discussion is available for on-line review, participants can respond to issues raised at any time, forming a hypertext-like discussion web posted on what is now a relatively linear medium. Romiszowski & de Haas (1991) suggest that this can encourage procrastination in response or failure to respond. When a sizable proportion of the interacting group does not post responses to raised issues, this can discourage overall interest in the idea-sharing aspects of CMC conferences. This makes it easy for participants to allow the discussion themes to drift. Asynchronous computer conferences are, therefore, "not only *multi level* (several themes in discussion) but also *multi speed* (different aspects of a theme being addressed by different participants)." (Romiszowski & de Haas, 1991, p. 54)

The Course

Despite these challenges, it can still be argued that a course designed to help educators become facile with all types of Internet resources, familiar with issues that impact instructional use of on-line services, and adept at designing instruction in which use of telecomputing tools is infused, should be situated primarily on-line, giving participants ample opportunity to experience the advantages and drawbacks to interactive, computer-mediated, asynchronous, text-based learning.

Internet-Based Telecomputing, a graduate course for K-12 educators and other instructional technology students, is an intensive introduction to the active exploration of Internet-based telecomputing resources and their infusion into existing primary, middle school, secondary, and training curricula. The class meets primarily on-line, with 3 day-long face-to-face meetings on Saturdays at the beginning, midpoint, and end of the semester. These meetings are considered to be extremely important by both students and instructor, since they expedite the process of community formation, team project planning, and learning to use different types of Internet resources in a guided hands-on format.

The asynchronous context in which the class is collaboratively created by all participants is one of an electronic community, supported and recorded by approximately 12 statewide Usenet newsgroups (organized according to article topics, such as resource announcements, technical assistance, weekly readings discussion, and lesson/activity ideas) and private electronic mail exchanges. Students learn to use these services, along with interactive (Telnet) access to remotely located programs, FTP file transfers, LISTSERV discussion groups, information locators (such as WAIS, Gopher, and Archie), and others, by exploring Internet sites suggested by the instructor or their classmates, then sharing reactions, curricular incorporation ideas, and access tips with the group.

Project work for the course is completed both individually and in groups of various sizes. A class-compiled "Internet Resource Directory for Educators," which lists, describes, and provides novice-level directions for use of different sites appropriate for application in K-12 classrooms with telecomputing access, comprises the bulk of students' project work. Each student is responsible for exploring several different self-selected Internet site types both individually (for small-scale Telnet sites, LISTSERV groups, and national/international newsgroups) and in teams (for large-scale Telnet sites and FTP sites). Each entry in the IRD is field-tested on-line and critiqued by classmates; successive drafts are exchanged on-line among feedback group members. The IRD is updated and expanded by each group of students who register for the course in successive semesters, then made available to the general Internet community via LISTSERV announcements of anonymous FTP sites that include the directory.

A final project that proposes a forward-thinking infusion idea incorporating use of several types of Internet resources in a classroom-based or training activity is planned, field-tested, and revised by teams of graduate students working with the educators for whose use the activity is designed. The idea is then shared through the writing, revision, and (optional) submission of an article manuscript to instructional technology journals such as *The Computing Teacher*, *Educational Technology*, or *ED-TECH Review*.

Ongoing on-line discussions, which all students are required to read each week, and to which all are also required to contribute regularly, address issues such as free speech in electronic contexts, K-12 access to telecommunications resources, electronic copyright, telecomputing support of lifelong learning, and human networking as a social/historical/ideological trend. Published research on use of telecomputing tools in education, business, and leisure is reviewed and discussed seminar-style, with different students reading and summarizing different studies, then leading the on-line discussions that relate to each.

Paper-based readings for the course for the Spring 1993 semester include Krol's *The Whole Internet* (1992; O'Reilly and Associates) as a technical guide, Lipnack & Stamps' *The Networking Book* (1986; Routledge & Kegan Paul) as an introduction to the "big picture" of networking as a social, historical, and ideological trend, LaQuey's *The Internet Companion* (1993; Addison-Wesley) as optional novice-level background reading on the Internet, and an instructor-compiled packet of shorter readings, user directions, and resource lists. Students are also required to locate, read, and share information on telecomputing research and applications according to specific areas of personal/professional interest.

Students keep logs of their telecomputing activity, and estimate that they spend an average of 6-10 hours each week on-line doing work related to the class, which is about double what is required. (Many jokingly refer to Internet exploration as "an addiction.") Most prefer to go on-line at least once per day, often at night just before going to bed; the majority of the students have purchased modems to use with their home and/or school computers rather than use the university's public computer facilities. Many students also take it upon themselves to voluntarily share the information that they discover through their course-related work with other educators, even to the extent of scheduling workshops that they teach, sharing printed copies of the resource directory, introducing university faculty who teach other courses in which they are enrolled to Internet-based resources, or providing information to the Internet community at large via public LISTSERV or newsgroup discussions.

The instructor in this rich interactive context certainly learns as much as the students, although the focus of her learning is concentrated more upon method, rather than content. The scope of this paper is not broad enough to include delineation of all methodological lessons encountered in such a dynamic teaching/learning context. Instead, a few key suggestions for other instructors seeking to incorporate telecomputing tools into postsecondary education that have been substantiated by faculty with similar experience can be shared.

Facilitating On-line Learning

Most graduate students have not yet experienced classes taught primarily or entirely on-line. The sense of place, therefore, is extremely important to communicate as quickly and as positively as possible. Romiszowski & de Haas (1991) suggest the following strategies to help establish a welcoming environment for students, especially those who have not previously participated in on-line courses.

- leave a personal welcome message for each student;
- reinforce early attempts at participation;
- reference students' responses in your comments;
- send students individual (private) communication that provide feedback;
- model expected behavior, concentrating on content and thought provoking ideas, rather than such things as keyboarding skills and formatting (p. 54).

Students' early on-line experiences are critical; if these are not perceived to be successful, they will probably encounter a semester of struggle, rather than a period of self-motivated discovery and sharing.

Although on-line teaching (comprised primarily of hosting, providing guidelines, moderating discussion, catalyzing groupwork, and the like) is probably more an art to be practiced than a set of skills to be acquired, Romiszowski & de Haas (1991) provide a helpful set of suggestions for being an on-line group facilitator.

- keep the main discussion on track by providing leading questions;
- if the discussion starts getting off track, refocus;
- if a distracting topic appears that is generating interest, create a branch so that the competing conversation is separate but optional;
- focus effort by suggesting that students look deeper into topics when applicable;
- provide summaries of what has been transpiring by drawing together main themes.

When CMC is expected to promote instruction, students need to be provided with clear guidelines as to what is expected of them (including the frequency of their participation) and how to participate." (pp. 54-55)

Harasim (1990) emphasizes that "...asynchronicity is not atemporality. While there is more flexibility over the time of an interaction on-line, timeliness in discussing the current topic remains important." (p. 47) It is probably more important to set and enforce specific deadlines and participation requirements in primarily asynchronous learning environments than in traditional face-to-face contexts.

The characteristics of the context itself can be created, in a more global way, to insure the success of teaching and learning on-line. Levin, Kim & Riel (1990) suggest that the following five participant structures will help to create a well-functioning network community:

1. A group of people who work together or share interest in a task, but who find it difficult to meet in the same location and/or at the same time
2. A well-specified task to be accomplished by this group
3. Ease of access to a reliable computer network
4. A sense of responsibility to the group and/or task
5. Strong leadership and final evaluation of the group task (p. 189)

Because the nature of participation in on-line activities is rather fluid, Levin et.al. (1990) recommend the use of electronic task forces (*teletask forces*) comprised of people with diverse abilities and similar task-oriented interests to complete relatively short-term projects. For instructional goals that require longer-term interaction than teletask forces, Levin et. al. (1990) recommend developing electronic apprenticeships (*teleapprenticeships*), in which novices learn within the context of the electronic domain itself, with the periodic, personalized guidance of a more experienced network user. Relationships such as these developed quite naturally among the members of the Internet classes, even among novices who had experimented, for example, with different resource types, telecommunications software, or addressing schemes.

Students are often emphatic in their requests that college and university education faculty "practice what they preach" when teaching graduate courses, especially those which cover new ideas about and techniques for instruction. It is clear, therefore, that the use of asynchronous CMC tools to help educators to explore and infuse Internet-based services is appropriate. The ways in which these experiences are best organized and facilitated are still open for consideration, though, being as dynamic and collaboratively-formed as the discourse within the on-line contexts itself.

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Internet: An electronic extension of the classroom

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Several faculty members in the Department of Technology and Education at Mississippi State University (MSU) initiated a project in 1991 to encourage teacher education majors to begin incorporating resources available through the Internet into their studies . The initial phase of the project involved requiring students in specific classes to obtain a campus electronic mail account. Once the students were on the electronic mail system, they were to begin exploring it. Limited feedback in class was sought, so students gained limited benefit from this first telecommunications experience. This process had potential, but needed more organization.

During the spring of 1992, an organized plan for preservice teachers to use the Internet was created and put into practice. John Perry arranged for each student in his *Methods of Teaching Basic Business Subjects* class to acquire an electronic mail account so they could access the Internet. Educators and professionals around the world were invited to converse electronically with these students. Many in-class discussions revolved around methods in which information gleaned from their global contracts could be infused into lesson plans or instructional practices. Incorporation of telecommunications into this class scheme was quite successful.

One of the educators who volunteered to communicate with this class was Ken Schmidt, a social studies professor in the Department of Curriculum and Instruction at the University of Wisconsin-Eau Claire (UWEC). When he was introduced to the kind of activity in which students would be engaged, he asked, "Would you be willing to let your students talk with my students?"

The collaborative project between MSU and UWEC got into full swing during the fall 1992 semester. Approximately 280 students at MSU and 50 students at UWEC, along with the affected faculty at each institution, exchanged Internet addresses.

Students exchanged ideas, suggestions, and insights that were incorporated into class discussions as though this information had been gleaned from expert consultants. Faculty at MSU heard students make comments such as, "Heidi said ...," or "Last week, Frank told me ...," or "This morning when I read my mail from Dean Dunlap, he told me that certification for probationary teachers in Wisconsin ..." We soon realized that these other personalities merely represented an extension of our classes. A key point is that the information was timely and students felt a sense of ownership in the body of knowledge being constructed in the course.

Faculty who participated in this telecommunications project have identified several positive influences on teacher education:

- multicultural revelations and exchanges

- impact of telecommunications on the "closeness" of a class
- sociological changes in students
- educational resource exchange
- administrative barriers to project continuation, and
- long-term relevance of project activities.

Other institutions are invited to participate in this project.

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Telecommunication training materials for teacher education

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Introduction: A Scenario

At long last! Mr. Cronbach had just received a modem through a mini-grant he had written entitled "A Classroom Without Walls." He had heard several of his colleagues speak of the wonderful potential of telecommunications—students exchanging data and activities with students in other countries, access to on-line database systems, information interchanges through on-line conferences, sharing ideas with other teachers. Mr. Cronbach tore the modem out of its box! It came with a manual, a power supply, a telephone line, and a cable to attach the modem to his computer. Thumbing through the manual and referring to his computer's user's guide, he got everything connected and plugged the phone line into the phone jack the principal had installed in his classroom.

Now, the moment he had been waiting for: He booted up his communications software, clicked on "dial," typed in the bulletin board system (BBS) dial-up number, and clicked "OK." Silence. Nothing appeared on the screen. Mr. Cronbach waited a few more seconds and tried "Redial." Again, nothing. Something was definitely wrong. He checked his modem connections, but they were fine. He opened his software manual and began reading. Parameters? Handshake? Stop Bits? Parity? Emulation? Port? He read further and realized he needed some information about the BBS. He got his account information and found the listing of possible settings, all of which varied depending on the communication software being used. Things were getting a little more complicated than Mr. Cronbach had anticipated. He had always heard that telecommunications was just like talking over the phone lines. This was beginning to be a little more complex than plugging in a telephone.

Mr. Cronbach went back into his software's setting section and made some choices based on the information he had read. He clicked on "Redial." This time he heard dialing tones, followed by a static sound. Garbled letters began racing across his screen. He pressed Return; more garbled letters appeared. He clicked on "Hang-up," and felt his blood pressure rising. He decided to edit his software's setting section. He changed the emulation, data bits, and parity. He clicked on "Redial." Again, Mr. Cronbach heard dialing tones, followed by a static sound. Words appeared on the screen! Mr. Cronbach sighed with relief. Whatever he had done, it obviously worked.

The words on the screen said, "Please log in." Mr. Cronbach entered his name and pressed Return. An error message appeared. The computer screen stared back at him, "Please log in." He looked back at his BBS reference guide and found the directions for the information he needed to type. (Perhaps, he thought, something he should have done in the first place.) In his haste to proceed, he mis-typed the log in command. When he went back to delete the characters, his delete key would not move the cursor! He pressed Return to start again. Instead of the regular error message, the system came back with the message, "Please contact your sysop" and disconnected him.

Mr. Cronbach looked over to his modem and began thinking about its potential as a paper weight. He would try one last time. He clicked on "Redial." Dial tones and static sounds pierced his ears. The "Please log in" prompt appeared. Slowly and carefully, Mr. Cronbach entered the log in information. The screen scrolled. Mr. Cronbach sighed. It now asked for his Username. Slowly and carefully, he typed in his username. The screen scrolled. Next, the system asked for his password. Slowly and carefully, he typed in his password from the BBS information guide. The screen scrolled. He was welcomed to the BBS. To make a selection on the menu that appeared, all he had to do was type the menu command and press the PF12 key on his keyboard. Mr. Cronbach looked. None of his keys were labeled PF12.

The frustration and confusion that teachers may experience when first learning about telecommunications is an unnecessary obstacle to providing students "classrooms without walls." Unfortunately, lack of teacher training and support continues to be a challenge for technological advancements in many schools. To encourage the use of telecommunications by Florida educators, the Florida Department of Education, Bureau of Educational Technology, and the Florida Information Resource Network (FIRN) have provided funding for training materials. The components of these materials are described in this paper.

Background

Several years ago, the Florida Legislature, through the Department of Education, established the Florida Information Resource Network (FIRN). This wide-area telecommunications network was primarily used to connect data centers and computer resources at universities, community colleges, and school districts.

In 1991, the electronic mail component of the system (FIRNMAIL) was expanded to provide free use for all public educators. Teachers and students now can retrieve information from remote databases at the state universities, including the on-line library catalogs and ERIC (Educational Resources Information Center). They can also download a weekly teacher's guide to NewsWeek or image files of satellite weather. In addition, through FIRNMAIL, educators can send and receive messages to other educators throughout the state and participate in conferences of common interests.

To meet the needs of FIRN users, there are ten technical support personnel (FIRNTECs) located at various sites throughout the state. Using telephones or electronic mail, the FIRNTECs provide assistance on hardware and software issues. They also conduct training sessions for teachers and administrators.

The FIRNTECs have been extremely successful in meeting the technical needs of the network. They do not, however, have the time to produce the range of instructional materials required by new FIRN users. For that reason, the Florida Center of Instructional Technology (FCIT), one of four "satellite" centers funded by the Florida Department of Education to assist educators, was asked to design and develop a variety of products, including a booklet on telecommunications basics, computer tutorial/simulations, and brochures.

Booklet on Telecommunication Basics

Telecommunications vocabulary, such as parity, half-duplex, and terminal emulation, is almost a foreign language to many educators. In addition, it can be frustrating for novices in the field to determine which modem to buy, how to connect it, and how to ensure the proper software settings. To provide guidance for teachers, a booklet, entitled *Telecommunications Basics* was written. The booklet is composed of four main sections, including:

1. Educational Applications for Telecommunications
   This section outlines several advantages provided by utilizing telecommunications in educational environments. Broad areas, such as "access to experts," are expanded with short case studies or examples.
2. Hardware
   The hardware section provides procedures for selecting and installing the hardware components. Detailed graphics are provided to illustrate the configurations required to connect a modem to an Apple IIe, Apple GS, Macintosh, and MS-DOS computer.
3. Software
   In the software section of the booklet, educators are introduced to the concepts and settings required for baud rates, stop bits, terminal emulation, and other parameters. Sample telecommunication software programs are referenced as examples of communication settings.
4. Commercial Systems
   The final portion of *Telecommunications Basics* is devoted to commercial systems for telecommunications. A brief description of each system is included, as well as contact information.

The booklet also includes several appendices, including a generous glossary of terminology, a list of technical support personnel, and dial-up numbers for local access to the state network.

Computer Tutorial/Simulation

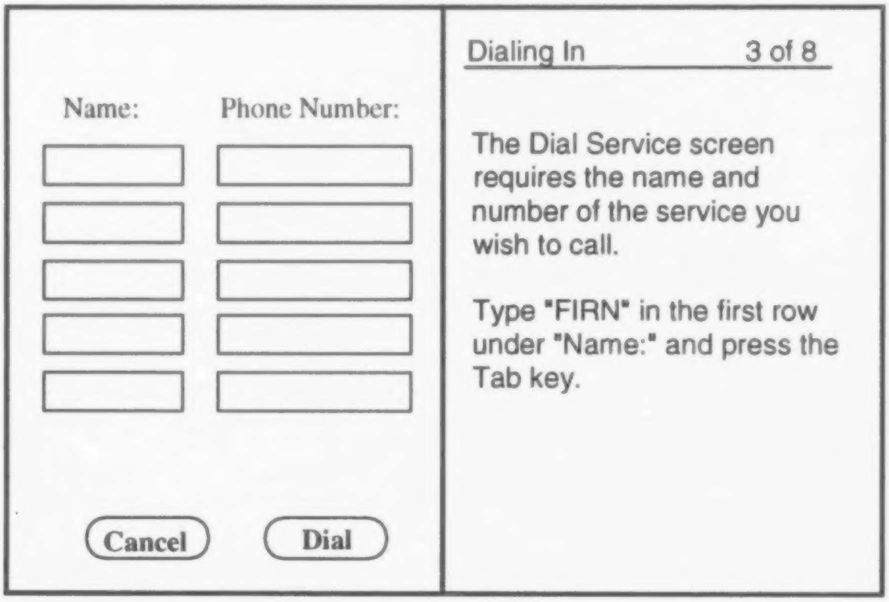
Florida provides a free electronic mail system (FIRNMAIL) for educators. Although it is primarily a menu-driven system, new users often need help with the interface. For example, the software was originally developed for a VAX mainframe and several of the commands refer to a "Gold" key. There is no "Gold" key designated on microcomputers, and users can easily become frustrated looking for one.

Another feature of the FIRNMAIL software that can cause confusion is the concept of the electronic folders. Each user automatically has five folders (Inbox, Outbox, Created, Read, and Wastebasket). Knowledge of these folders is important for users to find, retrieve, and delete their messages.

In order to provide a means by which educators can familiarize themselves with FIRNMAIL, a computer simulation was developed. This program enables users to practice creating and sending messages without obtaining a FIRNMAIL account, a modem, or a telephone line.

The computer program was designed with four major categories. Each category is a Main Menu selection that can be accessed in any order, or repeated, if desired. Throughout the program, maximum learner control is provided with permanent options such as Review, Return to Menu, and Exit. In addition, users can access a course map to determine their location or navigate through the program. A glossary of terms is permanently available also. The program contains the following sections:

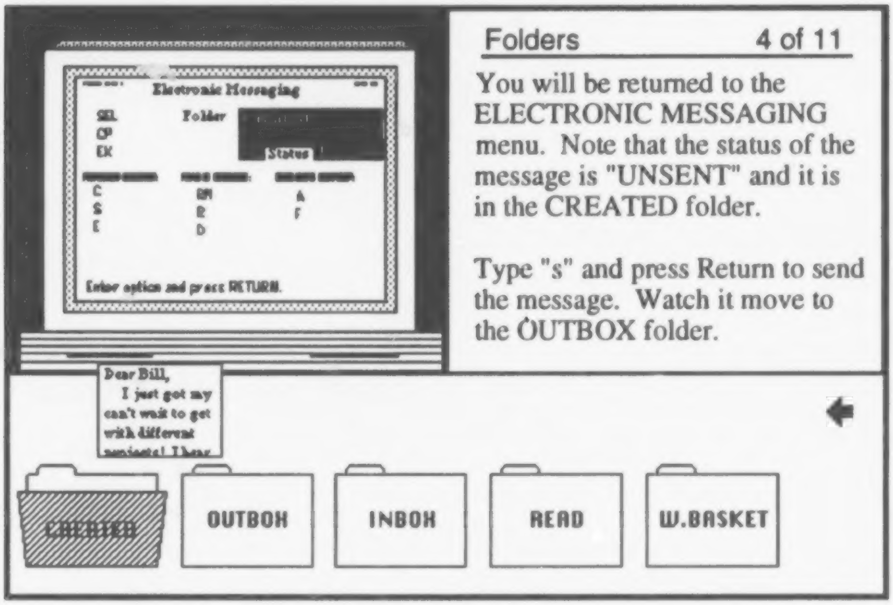
1. Telecommunications Basics.
   The first section of the program provides introductory information on telecommunications. Configuration requirements are outlined and illustrations are provided for connecting modems to various computer types. In addition, communication software settings are defined with a simulated screen. Students also interact with the program to enter dialing instructions in the software (see Figure 1).
2. Introduction to FIRNMAIL
   The second portion of the lesson focuses on FIRN and FIRNMAIL. After providing background information, the program introduces the concept of electronic folders for storing messages. In order to make the abstract concept of folders more concrete for the users, the program includes animations depicting the movement of messages from folder to folder (see Figure 2).
3. FIRNMAIL Simulation
   The third segment contains a detailed simulation of FIRNMAIL. Students can emulate the exact keystrokes and procedures required to create, send, read, index, and delete messages (see Figure 3). The lesson



The Dial Service screen requires the name and number of the service you wish to call.

Type "FIRN" in the first row under "Name:" and press the Tab key.

Figure 1. Sample dial-up screen.

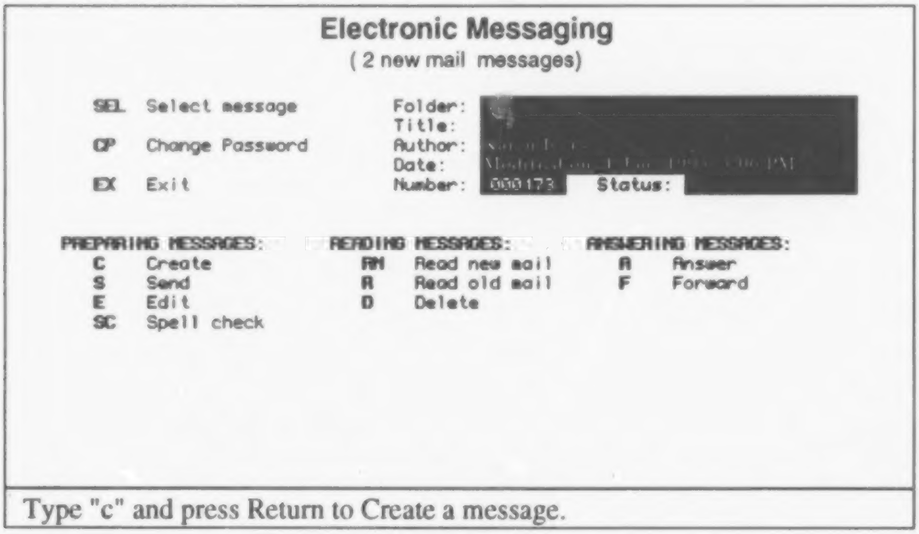

Electronic Messaging
SEL
CP
EX
Folder
Status
C
S
E
RM
R
D
A
F
Enter option and press RETURN.
Dear Bill,
I just got my
can't wait to get
with different
CREATED
OUTBOX
INBOX
READ
W.BASKET

Folders 4 of 11

You will be returned to the ELECTRONIC MESSAGING menu. Note that the status of the message is "UNSENT" and it is in the CREATED folder.

Type "s" and press Return to send the message. Watch it move to the OUTBOX folder.

Figure 2. Animated message folders.



Electronic Messaging

(2 new mail messages)

```
SEL  Select message       Folder:
                          Title:
CP   Change Password      Author:  [illegible]
                          Date:    [illegible]
EX   Exit                 Number:  000173   Status:

PREPARING MESSAGES:        READING MESSAGES:        ANSWERING MESSAGES:
 C    Create                RM   Read new mail       A    Answer
 S    Send                  R    Read old mail       F    Forward
 E    Edit                  D    Delete
 SC   Spell check
```

Type "c" and press Return to Create a message.

Figure 3. Captured system screen.

is very realistic and uses the student's name to produce a FIRNMAIL identification name similar to that of the FIRNMAIL system.

4. Applications
   The final section of the courseware provides information on applications. A list of the names and focus areas of several commercial applications is included. The address and telephone number of the vendors are also provided for those seeking further information (see Figure 4). Similar information is included for applications that are specific to Florida and FIRN.

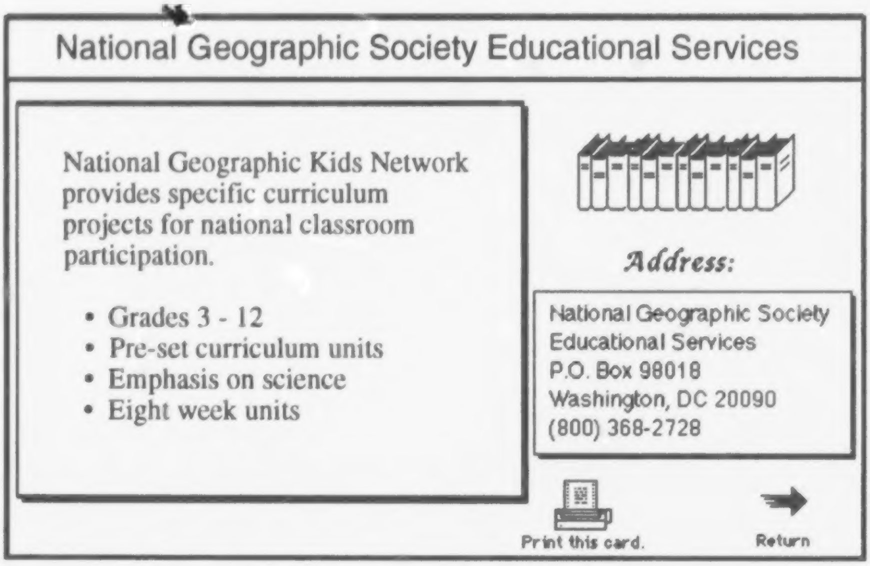
Brochures for Electronic Access

In addition to FIRNMAIL, Florida's educators can access several other electronic databases through FIRN. These systems are free of charge and are available through local dial-up access numbers. The systems include:

- LUIS (Library User Information System)
  LUIS is the on-line card catalog system of library materials found within Florida's State University System.
- ERIC (Educational Resource Information Center)
  ERIC is a large database of educational journals and reference materials.
- FCIDS (Florida Curriculum Information Database System)
  This application provides information for teachers and guidance counselors in Florida.
- Free for Teachers Database
  This database is an automated clearinghouse of Florida-based programs, materials, and other environmental education information.

The database systems are housed at various mainframe computers throughout the state and do not have standardized interfaces. For example, FCIDS uses an IBM mainframe and users must emulate PF keys for commands. FREE for Teachers requires users to communicate with KP (keypad) commands, and FIRNMAIL utilizes GOLD keys.

In addition to the confusion caused by the nonstandardized interfaces, many systems have unique log-on and log-off procedures. To provide some guidance for users and to enhance the use of these systems, quick reference guides and brochures were developed for each application. The quick reference guides provide clear and concise procedures for accessing and exiting the systems. They are produced on card stock and connected with a ring for ease of use.



National Geographic Society Educational Services

National Geographic Kids Network provides specific curriculum projects for national classroom participation.

- Grades 3 - 12
- Pre-set curriculum units
- Emphasis on science
- Eight week units

Address:

National Geographic Society
Educational Services
P.O. Box 98018
Washington, DC 20090
(800) 368-2728

Figure 4. Sample commercial application screen.

The brochures expand on the quick reference guides and provide additional information on the use of the systems. Dial-up access numbers are included in the brochures, as well as sample searches and substitution keystroke commands for terminal emulation.

Conclusion

The booklet, brochures, and simulation are being used to encourage and enhance the use of telecommunications and FIRNMAIL in Florida. They are disseminated free of charge by the FIRNTECs and the Florida Center for Instructional Technology. Through these and other products, teachers can explore telecommunications and become "TeleConfident."

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Grassroots telecommunications: An alternative teacher education resource

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A Grassroots Model

TC Forum and its associated Nebraskan Bulletin Board Systems grew out of the needs of educators to:

1) develop a distant teaching computer instructional model for training teachers, school administrators, and community leaders on sensitive and contemporary educational concerns, problems and issues; and
2) provide empathetic support and consultation to community members who are actively engaged in the positive solution of these concerns and issues.

The system was conceived by community college, teacher preparation and vocational educators. It was developed by these same educators and is maintained by them. TC Forum is a grassroots operation from its conception to its present day operation. Thus, it solves many telecommunications problems in a manner that is grasped by non technical users, i.e.,teachers, students and community leaders. It is free, accessible, and friendly. With few exceptions, software is public domain or shareware. Sub-systems are relatively easy to set up and maintain. Servers can be operated by anyone with a fair knowledge of MS-DOS operating systems. They can be adapted to regional needs or interests, and can be made very user friendly. TC Forum, as well as its associated regional host systems, are locally based but exchange information nationally and internationally.

The model, as a combination Internet and PC Bulletin Board System (BBS) model, had several advantages which led to its implementation. As a PC-based model, TC Forum could be duplicated at any level, any place where a computer and phone line were available. Thus, it could reach the most remote locations.

It is possible, of course, to implement an Internet-based telecomputing system using personal computers as the foundation for a distributed network. Notably, the Virginia Public Education Network (PEN) was established using 80386 microcomputers linked to the Internet through Serial Line Internet Protocol (SLIP) connections, with teachers in local school divisions who served as volunteer system administrators for local servers (Bull, Cothern, & Stout, 1991). In Nebraska TC Forum provides a similar grassroots, PC-based system, although the links to the Internet are indirect rather than direct.

The user interface provided to access the Internet at many universities may be less than intuitive for novice users. This is a characteristic of the local interface rather than the Internet itself. For example, inexperienced users often find RN, a widely used program for reading newsgroups, difficult to fathom. However, other news readers are much more accessible for the novice. Kearsley and Lynch (1992) have noted that the "Internet is a complex global network that requires considerable computer expertise to use." It is certainly true that the Internet is a very large network, with more than a million servers, and that some resources accessible through the Internet may require experiences for effective use. However, with the proper interface, many Internet resources are accessible even to users with limited computing experience.

TC Forum provides access to the Internet, but local menus can be configured by individual school systems. TC Forum can be configured to meet user needs and computer hardware even when accessed through Internet. There is no need to map keyboards or learn alternative functions to keyboard keys. TC Forum is accessible from MS-DOS computers, Apple II computers, Macintoshes, and mainframe terminals. The user interface employed uses simple menus to explain commands that correspond with the user's existing keyboard definitions. Although joy sticks and mouse "point and click" commands do not work on the system, this limitation only causes observable initial problems for Macintosh and Microsoft Windows users.

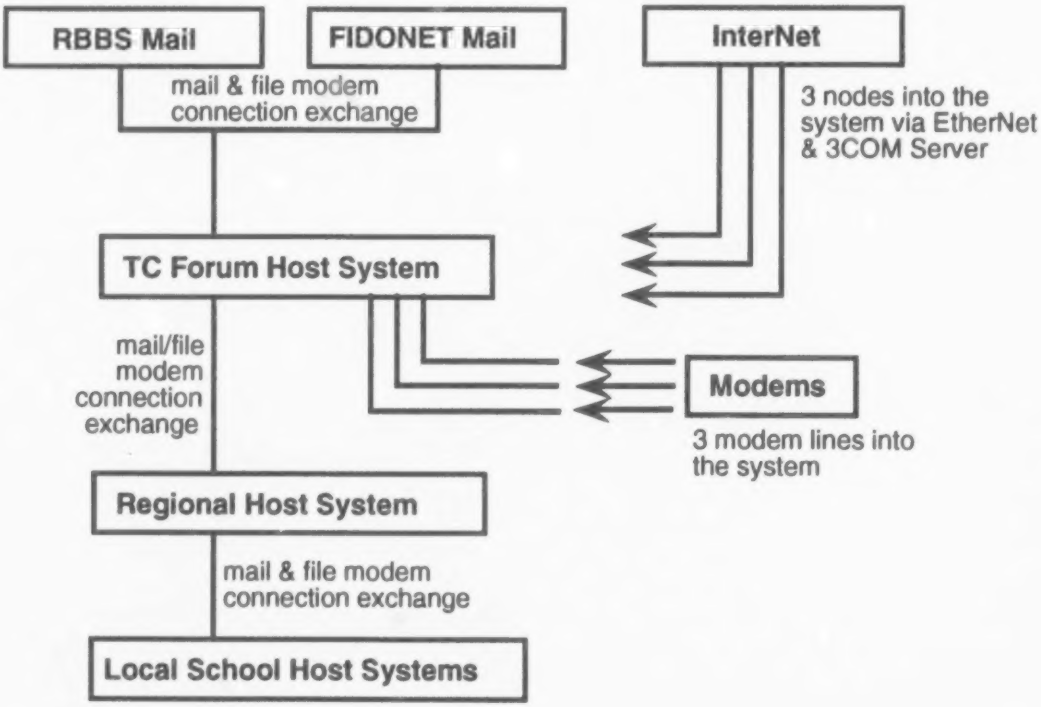
Development of TC Forum

Nebraska is experimenting with two educational telecommunications systems:

1) an Internet based system operated on UNIX boxes under the regulation of the Technology Center at the Nebraska Department of Eduction, housed and technically supported by the University of Nebraska, Lincoln, computer center; and
2) a modem-dependent system operated on DOS personal computers (using FIDONET and RBBSNET electronic mail networks) that is jointly hosted by TC Forum at Teachers College, University of Nebraska, and the Nebraska Department of Education curriculum division state colleges, community colleges and regional educational service units in the State.

TC Forum is a PC-based system operated by the Teachers College at University of Nebraska, and one of Nebraska's PC based electronic mail hosts. (The Department of Education delivers K-12 curriculum resources and Teachers College delivers higher education resources as well as community and teacher support, and adult education resources.) This system is directly accessible via three phone lines and through three Internet connections. It is also electronically networked by modem to 20 institutional sites throughout the state, many of which are,

Network Structure of TC Forum


RBBS Mail
FIDONET Mail
InterNet
mail & file modem connection exchange
3 nodes into the system via EtherNet & 3COM Server
TC Forum Host System
mail/file modem connection exchange
Modems
3 modem lines into the system
Regional Host System
mail & file modem connection exchange
Local School Host Systems

in turn, networked to local schools. Thus, TC Forum is serving a unique gateway position between Nebraska's Internet and PC systems.

As both an Internet and a local resource, TC Forum aims at contributing to teacher training, public school enhancement, and teacher development. It maintains and shares on-line bulletins and newsletters of interest to educators, electronic discussion groups on a variety of topics, courses and workshops, libraries of instructional software, and computer files, and on-line data bases. TC Forum functions as a clearinghouse for teacher education information, instruction, and communication. It supports interactive research through databases and questionnaires. It is thus a useful tool for both assessment and analysis.

TC Forum originated as a distance teaching project designed to connect teachers in the State of Nebraska with each other and the Teachers College at the University of Nebraska. Since the state is rural with small communities, teachers frequently lacked the professional communication and support vital to improving instruction. It was felt that a simple computer bulletin board system (BBS) on which both practicing K-12 teachers and teacher trainers could interact might help provide this communication and support. It would be an electronic means to inform educators about academic programs and courses, teacher workshops, and job opportunities.

While TC Forum was evolving, an important simultaneous development was on-going in the state. The Vocational-Technical Division of the Nebraska Department of Education was supporting the purchase of computers in community colleges and four year colleges with applied science programs. The idea was to develop bulletin board systems as a means to support vocational and technical interests in education. Many of these systems were financed by Perkins grants.

From this point, development grew rapidly and in several directions. The two separate programs combined efforts. TC Forum became the focal system for the growing statewide personal computer network. It joined the national Remote Bulletin Board System Network, a personal computer electronic mail and computer file exchange network, which allowed it to exchange messages and files worldwide as well as statewide. Another bulletin board system was set up in the curriculum division of the Department of Education which was connected to TC Forum. The Department of Education's system became responsible for developing, locating and delivering K-12 curriculum resources. TC Forum then became a node on the Internet which provided access to an even wider range of resources and links to teachers on the Internet. And finally, the statewide network was expanded to include regional K-12 Educational Service Units and thus, the schools themselves.

How It Works

A synopsis of TC Forum's structure is outlined in the chart on the next page. From the main menu, the user accesses specific areas of the system. Each area supports menus to access pertinent information and menus to allow deeper access into the area. (Nemeth, 1992)

One major feature of the system is the large number of local, regional and national technical conferences and discussion groups that are available. Questions may be posted in these message bases and answers received from other users as well as from specialists. These conferences cover topics which range from using word processors to using Unix, and from computer literacy to HyperCard instruction.

Another important feature of TC Forum is its ability to allow educators to respond quickly to special educational concerns and outreach topics. For example, three topics currently requiring special and immediate teacher training attention are AIDS Education, Multi-cultural Education and Assistive Technology Support. Most of the state's resources to instruct about these issues are located at the University of Nebraska, where TC Forum is based, so it becomes strictly an organizational problem to move the resources into the TC Forum model. After this, the delivery to teachers is effective and rapid. TC Forum becomes their window to world

As with other telecommunications systems TC Forum maintains a large selection of resources, both for on-line use and for downloading. Using a model such as TC Forum makes it possible to put the resources currently deemed most important in the spotlight. It also serves as a reference to other Internet resources by providing a central focus for education in the state. TC Forum maintains lists of other Internet resources and instructs users how to access them. Also included as resources are such materials as USOE Educational Statistics, ERIC summary reports, computer-assisted instruction programs (on-line and downloadable), school management programs and files, educational databases, separate support conferences for professional associations (i.e. Region 6 of the Cooperative Education Association), and on-line course instruction.

The Model as an Alternative Teacher Education Resource

In comparison to more traditional educational delivery systems, a computer-based telecommunications system has the advantages of flexibility and extensive resources. It is interactive, yet paced at each user's discretion. It can reduce geographic constraints and can also have the advantage of anonymity. No racial or sexual identification is necessary. Some of the particular features of the TC Forum model found valuable in these regards are listed below.

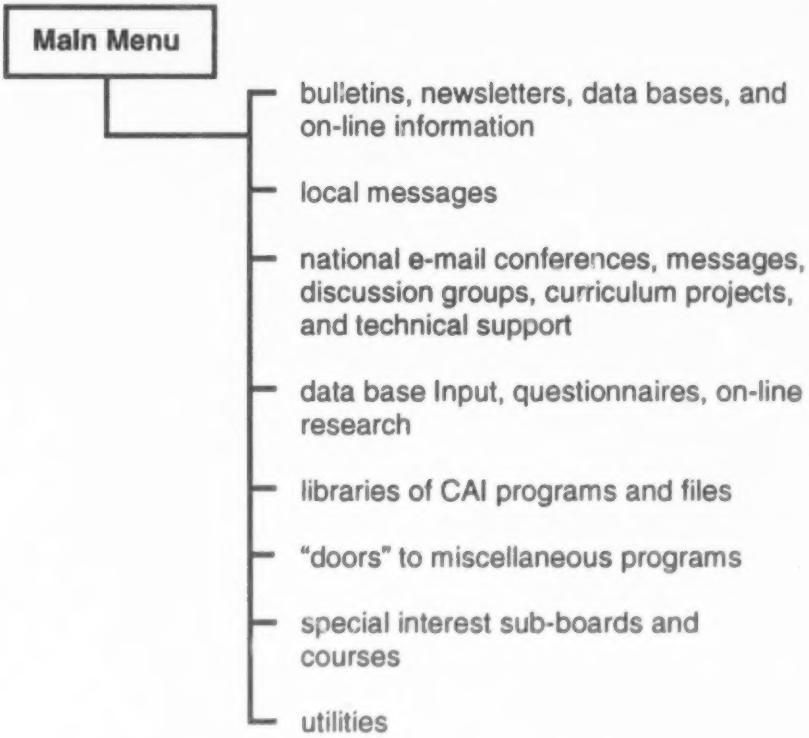

Main Menu
bulletins, newsletters, data bases, and on-line information
local messages
national e-mail conferences, messages, discussion groups, curriculum projects, and technical support
data base Input, questionnaires, on-line research
libraries of CAI programs and files
"doors" to miscellaneous programs
special interest sub-boards and courses
utilities

Figure 2. TC Forum's menu structure

First, the system never closes. Its operation is 24 hours per day. Teachers and students learn when they want to learn and for as long as they want to learn. The user controls the time schedule. And, because the TC Forum model is not dependent on per hour costs, or, in most cases, long distant phone charges, this aspect of telecommunications learning is advantageous and realistic for the TC Forum user.

Users work with many specialists. Isolationism is not as great a problem because the TC Forum model allows for regional, national, and international exchange of ideas and information through open discussion groups and the exchange of computer files and programs. Users can make contacts to solve problems; "listen in" to discourses, find technical, emotional and scholarly support, ask questions, and participate in subject debates. Remote areas are no long remote from an educational point of view.

Three examples illustrate ways in which special needs can easily be met:

1) TC Forum maintains a special private e-mail conference for first year teachers in which it is possible to exchange ideas and problems with each other and the faculty at Teachers College at the University of Nebraska at Lincoln.
2) For experienced teachers, a number of electronic mail conferences aimed at the sharing of instructional information, ideas, problems and solutions are maintained.
3) For young women (ages 13 +/-) who excel in sciences but who live in communities that might not provide encouragement for their talents, special conferences are maintained that allow them to interact with each other and accomplished role models.

Conclusions

The major lesson drawn from TC Forum experiences is that telecommunications in general can be an important and unique resource for the delivery of educational training, re-training and information to teachers who normally do not have access to such training and information. As a combined Internet and modem grassroots resource, it simplifies the telecommunications experience, makes it friendly, and localizes it to meet regional and specialized needs.

Initial costs can be as low as the purchase of a single microcomputer. As needs increase, the system can easily be expanded. Thus, extensive startup expenditures are not necessary. Costs can be kept proportional to benefits. However, there are a number of technical, administrative, political, cultural and economic factors not explored in this paper that must be taken into consideration to further the use of telecommunications as an alternative teacher education resource. Appropriate funding, training, planning and technical support are top contenders for attention. Germane tertiary level training for teachers of teachers, for higher education officials and for school administrators are other important concerns. And finally, provision of telecommunications to diverse social and economic populations is of paramount consideration if we do not wish to repeat the elite nature of present schooling. In this latter regard, a combined Internet and grassroots model such as TC-Forum can be advantageous.

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TC Forum Internet Address: telnet 129.93.80.233

Information technology for K-12 teachers

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RURALNET is a project intended to develop strategies and materials that encourage K-12 teachers in rural areas to use resources available through information technology. Based on the recommendations of selected public school teachers who will comprise an Editorial Board, project staff will use the Internet to construct an easily accessible file of curriculum materials. The file of materials, identified for their potential use as curriculum supplements in K-12 classrooms, will be placed on a fileserver—the RURALNET server—available to West Virginia teachers via West Virginia Network for Education Telecomputing (WVNET) and to teachers throughout the world via the Internet. Two features of the project will assure teachers' use of the fileserver. First, the project will provide a user-friendly interface between the server and the user. Second, it will structure a training process whereby teachers and school administrators—both inservice and preservice—can master rapidly the few steps needed to access the RURALNET fileserver. Cooperating in the development of this project are The West Virginia Board of Trustees System of Higher Education, The West Virginia State Department of Education and several West Virginia County Public School Districts.

This project when completed will accomplish two objectives:

1. Create, monitor and provide a methodology for identification and continuous updating of an Internet fileserver consisting of public and proprietary files of activities applicable for K-12 school classes. Emphasis will be placed on materials useful for rural schools.
2. Develop and recommend a curriculum for both preservice and professional development training of teachers in the use of these curriculum supplements.

The emphasis placed on this fileserver will be its applicability to public schools. It is through the use of computer networking that world wide resources may be brought to all rural parts of the nation and such a fileserver is especially applicable to rural states such as West Virginia. However, no restrictions will be placed upon access to this fileserver and it will be available to both urban and rural educators.

The project will emphasize the materials which are currently available on the Internet as well as materials which may be added. Students enrolled in teacher education programs as well as currently employed teachers must be prepared to take advantage of current files and such initiatives as the National Research and Education Network (NREN), the next generation of computer network technology.

Of equal importance to the identification of files to be placed in this fileserver will be the development of a model for use in pre- and post- teacher training concerning the availability of items on the Internet and specifically this proposed fileserver. The lack of adequate teacher training and the difficulty of identifying and accessing various useful K-12 files remain the two most prevalent reasons for the inadequate use of this bountiful resource.

This project has received financial support from the West Virginia Board of Trustees, the West Virginia University Department of Computer Services and the West Virginia University Office of the Vice President for Administration and Finance.

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KIDLINE: Electronic fieldwork in teacher preparation classes

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Although most teacher preparation programs include an early course in which students observe in classrooms, it is difficult to provide opportunities in the first year of the program for students to interact with children in an on-going field experience. In an effort to provide such an opportunity, and to begin helping prospective teachers become aware of the uses of computers in their classrooms, the author has introduced "electronic fieldwork" in a children's literature course typically taken by first year education students.

Students taking the course communicate throughout the semester with local public school students in grades K-6 on KIDLINE, a computer-assisted electronic conference for community schools. On KIDLINE, local school students can communicate with each other and with characters from the books they are currently reading by connecting via modem and accessing KIDLINE.

The software system used to enable the conference is CAUCUS, an interactive conferencing program created by Camber-Roth and distributed by Metasystems Design Group. This software enables participants who dial into the university mainframe computer and join the KIDLINE conference to read and respond to public discussion items (ideas, questions or comments put up by other participants). They may also communicate with any other participant in a "message" that is private.

University students are taught to use the system in the second session of the children's literature course. Throughout the semester, students may access the Caucus system in any one of several on-campus computer laboratories which have direct access to the university Vax Mail system. Those who have computers and modems may also access the system from their homes or dormitory rooms.

Once familiar with the mechanics of the conferencing system, university students begin their electronic fieldwork by communicating with the public school children in the KIDLINE conference. They may interact in several ways:

1) by playing a popular literary or television character,
2) by posting an item inviting students to talk to them, and
3) by exchanging private messages with specific students.

Usually the university students begin by playing a character because they feel it will give them more to talk about with their elementary pen pals. Some simply choose a character that appeals to them from a list of popular characters (i.e. Winnie the Pooh, Bart Simpson, Bilbo Baggins); others write a private message to one of the public school teachers asking what characters would appeal to their students from the books they are currently reading. After selecting a character, the university students post items on KIDLINE from their characters. An example of such an item and some of the unedited responses from the elementary students follows.

Item 6 30-SEP-92 9:49 Winnie The Pooh
Hello from Winnie The Pooh
Hallooo everyone! My name is Winnie The Pooh. Some people call me Pooh for short. I live in the hundred acre wood with my friends Eeyore, Owl, Piglet, Tigger. I would like to talk to some children. I am very lonely since I am stuck in my bear hole, and can't get out. Somehow the hole shrunk! I was just minding my own business and eating some honey. Now I can't get out. My paws are sticky with honey and they are sticking to the keyboard, so I will lick off all the honey and hope that someone will help me out of here soon. Won't you write me? Ta Ta for Now (TTFN)!
Sincerely,
Winnie T. Pooh
- - - -

6:1) T.C. Knoles School Kids
Hello, my name is Janie Wagner. I hope you get all that honey off of your paws. Once I was putting honey on my bisket and I got some honey on the table. I tryed to clean it with my hand but then all of a sudden I felt an itch on my head so I secrached it not noticing there was still honey on my fingers so I got honey in my hair. When I was done wath brectfes I washed my hair two times with condishiner and shampoo. I hope you do better than me.
Love, Janie
P.S. write back!
- - - - -

6:2) Kohl School Kids
hi my name is Molly and I hope you get out of the hole. maybe you can get Piglet to tickle you and pop you out. Don't eat eny honey and get it on yourslfe again.WELL BYE FOR NOW Molly
- - - - -

6:3) Winnie T. Pooh
Hi Allison and Molly! Thanks for writing to me. I'm glad someone out there can simpathize with my sticky situation. All Christopher Robin had to say was that I am a silly old bear. He said that my hole did not shrink, but that I gained weight from eating so much honey. I ate all the honey, so Christopher Robin thinks I will be able to squeeze out of here in a few days. I hope so! I want to visit my friend piglet and see if he has some more honey!
TTFN!
Pooh
- - - - -

6:7) Presentation School Students
Dear Winnie the Pooh,
How are you? How old are you? How are your friends? Are they Pigglet, Christopher Robin, Tigger, Eeyore and Rabbit? My name is Marisa, I am 8 years old. Do you have a Mom and a Dad?
Sincerely, Risa Martinez
- - - - -

6:10) Winnie T. Pooh
Hi Risa! How are you? I'm great because my friends are throwing me a birthday party. I don't know how old I am. I asked Christopher Robin and he just said I was old enough to know better than to eat too much honey! My friends Piglet, Rabbit, Eyeore, Tigger, and Christopher Robin are all here. Kanga and Roo couldn't come because they all have the flu. But Christopher Robin is going to bring them some cake anyway. Tigger is bouncing all over the place. I asked him why he bounces so much, and he said he swallowed a couch spring when he was very young. I don't think I have a mom and dad anymore, and I don't remember them, but I have good friends. I love all my friends and I couldn't possibly say I like one more than another. They are all different, and I love them all. Do you have lots of friends too?
TTFN,
Pooh
- - - - -

Another notable item was one in which Bilbo Baggins corresponded with a student over an entire semester. The student became so attached to the character that she couldn't wait to get back to school after summer vacation to write to him again. Following is an unedited sample of their correspondence.

- - - -

Item 64 Bilbo
A Greeting from Bilbo

I'm pleased to meet you young folks. Some of you may have read my book, and therefore already know a little about me. I always called the story "There and Back Again," or "A Hobbit's Holiday," but in your world I think they just called it "The Hobbit." I'm not sure I like that. It makes it sound as if I were the only one! The only Hobbit, that is.

I'm sorry if I am wandering a little bit. You see, I am very, very old. Much older than most Hobbits. Gandalf, the Wizard, says it is because I found that magic ring many years ago down under the Misty Mountains. Gandalf can be a gloomy fellow. He always warned me not to use the ring. He said it would have a bad effect on me. But it was so useful for certain things. When I put it on, it made me invisible. I had some relatives that I didn't like, and when I saw them coming to my house, I would put on the ring so that they couldn't see me.

Say, do you know what hobbits look like? We're very small—much smaller than humans. We stand about as tall as an eight year old human child. We have thick leathery soles and lots of hair on top of our feet—we never have to wear shoes.

And we love to cook and eat. I eat six times a day when I get the chance. Last night I had roast duck and fresh home made bread.

But I shouldn't just keep talking without hearing what you have to say. I suppose you'll want to hear about my adventure, how I talked to the dragon Smaug and helped restore the Kingdom Under the Mountain and all that. What do you young folks like to talk about?

Your Friend,
Bilbo

- - - - -

64:2) Hazelton Kids

Dear B

- - - - -

64:3) Bilbo

Dear Hazelton Kids:

How alarming! I just received your message and it makes me wonder what happened to you. Did a goblin grab you from behind just after you typed the letter B? I do hope that you will be able to write to me and explain. It would make me very sad to learn that some monster had eaten you for dinner or something like that. But then you don't have goblins in California, do you? Do you have dragons? I heard once about something you have in California that sounded a lot like a dragon. Hmmm, what was it?

Oh yes, it is called an earthquake or a trembler or a tremor? And I've been told that it can knock a whole city flat, just like a dragon! Have you ever seen an earthquake swoop down out of the air and destroy a city? I would love to hear more about these creatures. Can you talk to them? I talked to a dragon once and I nearly got killed for it. Well, please write as soon as you escape from where ever you are being held hostage.

Your friend,
Bilbo .

- - - - -

64:4) Hazelton Kids

Dear Bilbo,

Hello, my name is Sara Ann Woolsey. And I go to Hazelton School. I am sorry that I didn't finish my letter, but a monster like creature grabbed me from behind. It had fire red scales that were slimy and gooey. Its eyes were black as coals and it seemed as they looked right inside of me! Its talons were long and curvy and it hurt when it picked me up! Ouch! Out from its snout came long columns of sweet smelling smoke. When it breathed, fire came out and it tickled my nose. Just as it was about to eat me, a heroic teacher named Ms. Sally Jones rescued me and killed the creepy monster! It was quite an exciting afternoon.

Well, now that I have told you about what happened to me, I will tell you a little about myself. My hobbies are reading, writing, drawing, and riding my roller-skates. Roller-skates are shoes with wheels that people use for fun. I have strawberry-blonde hair that is about shoulder length. My eyes are a light brown with a teeny-tiny, super small amount of green in them. I have slightly tan skin with brown freckles across my nose. My favorite food is pizza. Pizza is round shaped bread...that has cheese and tomato sauce. You can put almost anything on the top of it to eat.. Pizza is said to come from Italy, that's another country. I love the rain. And purple is my all time favorite color.

Now I want to ask you a few questions. How did you get here from middle earth? Are all dragons mean and evil? Do you know any wizards? Are dwarves nice or rude? What is your favorite hobby? What is your favorite color? What is your favorite kind of food? Tell me about it! Do you have any pets? What kind of weather do you like? Also, tell me more about yourself. Well, I have to go now. Please write back A.S.A.P. (as soon as possible)!

Your loyal fan,
Sara Ann

- - - - -

64:5) Bilbo

Dear Sara Ann:

You really will have to find a safer place to write, my dear. I got the shakes just reading your description of the horrid beast that was pawing at you. Is this Sally Jones who teaches you an Elf? If she is a mortal, how did she get her special powers to slay evil beasts?

I can tell that you are a very clever and kind-hearted girl because after frightening me with the tale of your encounter with the monster, you decided to lift my spirits with a description of a delicacy from your world. I pride myself on my cooking skills and I intend to make a pizza as soon as I can scrape together the ingredients. My favorite food in the whole wide world is MUSHROOMS! All Hobbits love mushrooms. Would mushrooms be good on Pizza? I think I will try it. I'll tell you the result of the experiment as soon as possible.

As to how I got here, I'm not quite sure where here is. I am here in Middle Earth as I always have been. You, obviously, are not. There are some things I don't ask too many questions about. All I can tell you is that Gandalf (A marvelous Wizard) knocked on my door one day and said he wanted to give me this funny little box called a Macintosh Classic. He said it came from a place called University of the Pacific. From various hints he dropped, I gathered that this University is a place where Wizards are taught to use their magical powers. Anyway, Gandalf said that since I have a lot of time on my hands. that I should write to wizards and children and teachers in the other world where this University is located. The Macintosh Classic is connected to a little white rope that goes out my window and into the ground next to a pine tree standing outside. Where the little white rope goes after that is anyone's guess. Gandalf probably knows but he got very rude and snippy when I asked questions about it.

I used to think that Dragons were evil but now I think that maybe they are so big and powerful that they do things that we small folk think are evil. A really big dragon could knock an entire city flat with one accidental flick of his tail! It is evil to us, but to the dragon it is just an infinitely small event, somewhat like what happens when one of us trips over an ant hill. The ants think it is evil, but we just wonder how we stubbed our toe!

The only wizard I know is Gandalf, and that is quite enough thanks! Dwarves can be both nice and rude. They are mostly good-hearted fellows. They will do everything they can to help you out in a pinch. But in day-to-day matters like discussing what to eat for breakfast they tend to be very abrupt and gruff. Dwarves also have a peculiar tendency to go into a frenzy when they catch sight of gold and jewels. Then their eyes glitter and they become very excited.

Cooking and writing are my hobbies and my favorite color is green and I see that I have written quite enough for today.

Your friend,
Bilbo

- - - -

64:7) Hazelton Kids

Dear Bilbo,

Hello, it's me, Sara Ann. This time I hope that no terrible thing will take me hostage! How is the weather where you are? Here it is raining. And I have to stay inside. Oh well, it will give me time to write letters on the computer.

So you love mushrooms, eh? Well, lots of people love mushrooms on pizza. You should try it! I bet you would like it. If you try it, tell me about it, if you liked it or not!

You asked that I tell you a little about my rescuer, Ms. Sally Jones. Well, she is very smart. She is not an elf, nor dwarf, nor wizard, she is a teacher! A teacher uses his or her BRAIN power against evil and badness. I better sign off before I get captured by weird things again...

A good friend,
Sara Ann

- - - -

Although lively, their letters had remained fairly formal during the first few months. Sara Ann always signed her letters, "Your loyal fan" or "Your good friend." She used a more familiar closing in her first letter to "Bilbo" after the summer break:

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2:2) Hazelton Kids

Dear Bilbo,

Hello good friend — it is I, Sara Ann, from Hazelton school! Do you remember me? I hope so, since I certainly remember you! Well, my trip to Romania was a delightful experience! Meeting new people, seeing different sights, and living the lifestyle of another country! Next year a girl from New Zealand (who is 12 years old) might come live with us for the month of July. Then in December I would go to live with her in New Zealand! How exciting! I truly hope I can go!

What has happened with you over the summer? I missed you! I'm glad we're back! It was a weird feeling without turning on the computer and having you there! But now we have lots more subjects to write about!

Uh-Oh. I'd better go. I certainly don't want to be late for class! Bye-bye!

Love,
Sara Ann

- - - -

Some university students feel confident enough to correspond with the elementary school students without benefit of a character "cover." Those who choose to do this are usually athletes who think the youngsters will be interested in their sport. The following item was posted by a member of the Women's Basketball team. The item and responses are unedited.

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Item 68 Tasha — Basketball

Yo! My name is Tasha. I am a member of the U.O.P. women's basketball team. I play all of the positions. If you have ever come to a basketball game, I am the person wearing jersey #34. If you want to chat about basketball or whatever, drop me a line anytime. If you ever want to work out, I am definitely a gym rat and would love to play anytime. Bye for now. Hope to hear from you!
Tasha

- - - -

68:1) Stuart School Kids

Dear Tasha,
Hi, I played on my school basket ball team.
I wasn't the M.V.P. but I was pretty good.
I was just woundering if you could give me a few tips on shooting free throws
Love, Sarah

- - - - -

68:2) Tasha

Hey Sarah, shooting free throws is 90% mental. you have to concentrate on the rim and placing the ball over the rim. Your feet should be placed about 2 feet apart, but no wider than an inch outside of your shoulders. When holding the ball, the ball should rest on your fingers and not the palm of your hand. Your shooting arm should form an "L" shape and your other hand should rest lightly on the ball. Make sure you bend your knees and push the ball up and follow through. The major thing, though, is saying to yourself every time as you step up to that line is—"this shot is so easy and it is going to hit nothing but net." Good luck on your free throw shooting let me know how it goes!
TASHA.

- - - -

68:3) Kohl School Kids

Dear Tasha,
I have seen you play because I come to every game. I wish I could play with you some day. Do you think you could come to our school?
Danny

- - - -

68:4) Tasha

Hey Danny, the U.O.P. main gym is open all the time. It is great and it doesn't get really crowded. You can call the athletic department and get the times that the gym is open. I'll usually be there and can play with you a while. That is the only gym that I play in. I am not from Stockton and don't have a car so I try to stay close to campus, but sometimes our mascot, Tommy the Tiger, takes athletes out to visit schools. I'll check that out for you. If he can bring me to your school I'll send you and your teacher a private message so we can set up a time.
—TASHA

- - - - -

68:5) Stuart School Kids

Dear Tasha
Thanks for the great tips.
It really helped us out a lot.
Love, Sarah

- - - -

One item that was popular with the university class and the local school children is a combination of "character" and "real" identities. One of the students in the children's literature class posted an item from "Bookworm" so that she could review all the books she was reading for class. She then started the responses as herself, but occasionally interjects comments from the character. Following is the item and a sample of unedited responses.

Item 4 Bookworm's Book Review

Hey everyone, read any good books lately? Well, here's the place to tell us about them. This is my book review for all students (UOP and elementary) and teachers too. Tell me about your books; title, author, why you liked it, and anything else you want to tell me. I am eager to hear from you because you know how bookworms are- always looking for new and exciting books to read! Until then... keep on reading!!

- - - -

4:1) Debby

Hi Bookworm! I just read 2 books of Fables that I found to be good. The first was "Splendid Tales" by Pleasant De Spain. It contained fables from many different countries. The illustrations are funny. Two of the fables I particularly liked were "The Bear Who Said North" and "The Two Wives." The other book was "FABLES" by Arnold Lobel. I liked all of the fables so it was hard to choose a favorite. One good one was "The Bear and the Crow." A crow gets this bear to believe that people are no longer wearing hats, vests, and shiny shoes. Instead they are wearing frying pans, bed sheets and brown paper bags as shoes. I'd definitely recommend this book. BYE!!

- - - - -

4:2) T.C.Knoles School Kids

Dear Bookworm, Hi my name is Molly. I read a book called The Ghost in the Big Brass Bed by Bruce Coville. It is about a girl namesd Nine and her friend Chris and their firend Norma is a friend of Pheobe Watson , the daughter of Cornelius Fletcher, a famous artist. Nine and Chris go to Pheobe's house and go to a to a room and look in the miorror and behind them is a big brass bed and they saw a ghost that was about 6 years old. It's spooky and really good. You should read it.Bye.

- - - - -

4:3) Stuart School Kids

Hi I'm Rachel. Let me tell you about this good book I read. The book I read was Henry Huggins. It was about a boy that found a dog and named him Risby. When he found him he didn't know how he would get him home. He tried to get him on the bus but the driver wouldn't let him on. Finaly another bus driver let Henry and Risby on the bus. When the bus started to move Risby jumped up and the bus was a zoo because he knocked over people's bags and they were all tring to pick up their things and were not making any progress. There's more to the story but I have to go now. Bye!
YOUR FRIEND, RACHEL

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4:4) BOOKWORM

Thanks, Rachel! That sounds like a good one!

- - - - -

4:5) Liane

Hey bookworm, I read a wonderful adventure book about a family (Mom, Dad, Baby, and two little brothers) who come to America in the late 1860's and are on their way to their new home in Minnesota! The book is written through the eyes of the two boys. They see America FOR THE FIRST TIME and they talk about their feelings and their impressions about it! Great historical book!

- - - - -

After posting an item, university students are required to check their items and any private messages they have received at least two to three times a week because teachers report that young students get very anxious (or lose interest) if their messages aren't answered in a timely manner. Although many older students (grades 5-6) realize that someone is playing the characters with whom they are corresponding, teachers report that their students remain excited about KIDLINE and want to check frequently to see if they have received mail from other students or their favorite character.

University students participating in KIDLINE have described their on-line experiences as beneficial because it has given them new ideas on ways to share their enthusiasm about reading with children. They indicate that the communication with the elementary students gives them a chance to better understand how youngsters in a wide range of grades think. One student commented, "I would never have enough time to go to schools and talk to such a lot of different kids. I have written to all ages and cultural groups in KIDLINE...and to kids with different levels of achievement!" University students also say they feel more prepared to use computers in their own classrooms. One said, "I was terrified of computers when this class started and dreaded this assignment—but it has really been fun...I'm asking my parents for a computer for my birthday!"

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Electronic conferencing: Extending discussion opportunities in teacher preparation classes

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Helping prospective teachers become aware of the uses of instructional technology (especially computers) in education is an important goal of today's teacher preparation programs. One way to familiarize prospective teachers with technology is to provide discrete courses in the use of microcomputers in education An alternative is to infuse technology into existing courses by requiring the use of a computer in learning course content that is not specifically focused on the computer. This alternative is especially powerful because it models for the students the possibilities of using computers in a variety of subject matter areas.

The typical teacher preparation classroom format allows for limited time for extended reflection and sharing on the many topics that are covered in class. Use of a computer with a telecommunications program can extend the opportunity for discussion and reflection on topics of concern from classes and related experiences. By writing about a subject, the students have the opportunity to think more clearly about it. In addition, the comments provided by students can enable the teacher to see what students are thinking and to better understand their individual concerns and problems.

The authors have used computers in a variety of classes in their teacher preparation program. This paper will discuss two ways an electronic conferencing system is currently being used at their institution to enrich two teacher preparation courses.

The software system used to enable these procedures is CAUCUS, an interactive conferencing program created by Camber-Roth and distributed by Metasystems Design Group. This software enables participants to participate in conferences concerning educational items in a public forum or a forum limited to class members, and communicate privately with conference participants on problems and issues that they do not wish to discuss in the public forum.

The authors begin by spending one or two class sessions demonstrating to students how they can get on-line and the mechanics of responding to and adding new items, sending and receiving messages. These introductory class sessions usually take place in a university computer laboratory in which the computers are directly connected to the university main frame VAX computer by which the Caucus system is accessed. In later individual sessions, students may access the Caucus system in any one of several on-campus computer laboratories which have direct access to the university VAX. They may also access the system from other locations using a telephone modem and an appropriate telecommunications program.

One effective method that the authors have used to get students acquainted with each other and with the capability of a telecommunications system to send and receive messages is to have a "Scavenger hunt" early in the course. When the students initially log on to the system, they are directed to send a private message to the instructor providing two facts about themselves which other students are unlikely to know. From those facts the instructor composes a scavenger hunt sheet listing pertinent facts and having blanks for student names. Students are directed to only ask other students for relevant information when they are on line. The first student to turn in a sheet (via the electronic mail system) with all names identified correctly wins a small prize.

FEI 175, Reading/Language Arts Development is a course taken by prospective teachers who have specialized in a single subject area, and plan to teach that one subject to several classes of students, typically in a middle school or high school. The focus of this course is on helping students develop strategies for using reading and writing as tools to more effectively learn the content of their particular subject area, be it in the physical sciences, social sciences, fine arts or humanities. In FEI 175, the instructor has set up an on-line conference for the class members and typically poses a new discussion item online for each new course topic. Students are encouraged to respond to the item and to comment as well on the reactions of their peers. An example of an item and some of their unedited responses follows:

Item 11 Peg Langer
Writing to Learn
Describe an occasion or a class where writing has helped you to learn and an occasion or class where writing was assigned but it didn't help you learn. What conclusions can you draw about effective teaching practices.

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11:1) Sally
As a history student; I have had to write countless essays and term papers (I'm sure Andy can vouch for this) and I think that I have learned from just about all of them, especially the term papers. As much as I hate writing term papers, they are one of my specialties because I love to research. One particular instance that writing has helped me learn was in an assignment in Politics of Asia, an upper division history/polysci. class here at the university. The professor worked with me to develop a very long (35 pages) and complex paper on China and the Gang of Four. It took me the whole semester and trips to several different libraries to compile, write, re-write, re-write, print, reprint and so on to get the best paper I could. To this day, I still remember most of the subject and look back with pride at being able to pull it off! That was just one example of an assignment in writing that helped me learn.
It was hard for me to think of an example when I didn't learn from writing. The only one I can think of was in my high school English class (no offense Joan!) when my teacher had us write sonnets. Other than showing us how hard it is to write a good sonnet, I didn't see a point in forcing the whole class to write sonnets for three whole weeks! I think we got the difficulty point after the first try! I'm sure there were other times when writing may not have been overly productive but I can't think of any right now.

- - - - -

11:6) Andrea
Unlike the rest of you, as a chem major I rarely have to write papers (or at least I didn't write many before this semester!) I think one of the most useful writing assignments I've ever done, was the research paper I had to write last semester for P-chem. The purpose of the paper was to get some experience writing in a format that is publishable for chemistry journals. For this reason, the actual subject wasn't as important as the format. Everyone in the class was able to pick a topic that was interesting and relevant to them. After a few talks with my Professor I did mine on the mass extinction of the dinosaurs, the volcanic and meteorite theories. I learned some new research methods, and how to write the proper way for a journal.
How many of you know how to write an abstract? How many of you know what one is? (I didn't until I had to write one.) My professor had each step of the process due at some point so none of us could slack. Not throwing the paper together the week before it's due helped my paper a lot. It was a really great experience, and now I'm not as scared of papers as I used to be!

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11:8) Dave
During my junior year in college I was required to write a paper for my religious studies class. The class was called "Religion in America." The paper required me to trace the roots of mine, my parent's, and my grandparent's religious background. Writing this paper was enjoyable because I had the opportunity to find out a little about my family history. It was not an easy paper to write, but it was informative eye-opening for me. A horrible writing experience came to me when I was a sophomore in high school. We were asked to write a term paper. None of us had ever written a term paper before so we were a little lost as to what the assignment would be like. Things would have gone a lot smoother for me if I had been given some more guidance during the whole process. I was told of the requirements of the paper and when certain aspects of it were due, but I was a little unclear about how to go about finding a pertinent topic. The teacher gave us no clues as to what to look for in a topic. I would have been much better off if the teacher had just told me to write about something controversial which effected my life. This would have given me enough information to get going in the right direction. Needless to say, I changed topics about three times before eventually writing on something like: "Jim Morrison-Alive or Dead."

- - - - -

11:10) Robert
Writing was difficult for me in high school, but it was always a satisfying experience as well. Perhaps one of my most rewarding writing experiences came in my Senior English class, a class

for which we had to do writing of one form or another almost every night. The assignment was a definition paper, and my topic was love. In other words, I was to define love in a four page paper. I went into the assignment with great enthusiasm, because love was something I valued very much and had thought a lot about; love, I believed, was the very foundation of my faith and life. But after writing the paper and receiving my teacher's feedback, I was very disappointed. My teacher "tore my paper apart", though he did so in a very gently way. Basically, my teacher informed me that my paper was full of clichés, and that much of the logic I had used was not communicated clearly in the format or language of the paper. This was quite a blow; I was a fairly confident writer, and I was writing about a subject that was important to me. But, in the end, my teacher's feedback was invaluable. Not only did he help me to see that I needed to think more deeply about many of the things that are important to me, but he encouraged me to try to develop writing skills that would allow me to communicate my thoughts in a coherent, effective way. He helped me to not only become a better writer, but a deeper thinker as well.

I have not had too many "bad" experiences with writing, though it often requires a great deal of discipline and work. The only time I don't enjoy writing is when I rush an assignment in order to meet a deadline and neglect the thinking and planning that good writing requires. Students should be given ample time to think about their topic, their audience, and their plan or format when given a writing assignment. Secondary students would benefit from instruction, modeling, and encouragement at every stage of the writing task.

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11:11)Edward

The class that I learned most from through writing was a health class here at the University. Our teacher was very knowledgeable but he had a tough time getting his ideas across to the students. He required many writing assignments that I benefited from greatly. He provided us with guidelines to follow.....The writing assignments not only helped me understand the content in the classroom, but they also helped me understand myself better. I began to understand my body better and what I needed to do to maintain good health. I learned nothing from my writing assignments in my high school history and government classes. My teachers did not provide proper guidelines to follow. More importantly they did not help us with writing. They didn't let us know what they were looking for. The time I spent writing the papers was wasted time. I learned nothing about the writing process, and nothing about the content material my teachers wanted me to. I conclude that if a teacher wants his/her students to be engaged in writing assignments that they have to do a good job of explaining. They need to let their students know what they are looking for in the paper. Provide for the students a guideline to follow. This will benefit the writers a great deal. We, as teachers must be there for assistance for the students. In order for students to enjoy writing, we must make the process understandable and exciting.

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A second course, FEI 135, Reading/Language Arts Development is a course taken by prospective elementary teachers. The focus of this course is on helping students develop strategies for directly teaching reading and writing. In FEI 135, the instructor has set up a similar on-line conference for extended discussion of class topics. In addition, students use the conference to keep a running log about the field work they are doing for the course. The field work item and some of the unedited responses follow:

Item 8 Sue Eskridge
Field Work#2 Assignment
I got a note from Kathleen after she visited Kohl School, where she will do her field work, that was really interesting. I have decided to post it for all of you to see...and to change the assignment slightly. I would like you to keep your log on Field Experience 2 in this item. After each visit, please describe (and assess) your visit here rather than in a written log. I think this will be helpful because everyone will be able to share in your successes, your feelings about what you are doing, and how you might do a lesson differently if you could repeat it. I will check off weekly entries, so you will not need to include the printed log when you turn in your field assignment .

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8:1) Kathleen
SUBJECT: Just a note about Kohl School
I just spent the most fantastic morning at Kohl School! Though I arrived at 8:30 am with the intention of spending an hour getting acquainted with students for my fieldwork assignment, I didn't actually leave until almost 1 pm !....I arranged to work with students from Jane's first, second, and third grade class. I also had the opportunity to meet the ENTIRE faculty, and observe ALL the classrooms where I witnessed whole language and an integrated curriculum in the works!!! I can't say enough about what a dynamic environment Kohl provides! Not only am I looking forward to working there, but I can tell it will be an invaluable learning experience for me as well! Jane told me I can do anything I want in her classroom. She is going to help me incorporate my ideas into a teaching unit which encompasses most of the learning objectives mentioned in your assignment! I just had to share all this with you! Good-bye for now.

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8:12) Sisouat
I taught two lessons last week in Cleveland school. I worked with six Cambodian students, and they were in second grade. My first reading lesson was about the shadow. These six students were at the lowest reading level. Mrs. Ling would like me to work with them because they did not understand English well. I read the story with them line by line. I wrote vocabulary words on the blackboard so that they can see the letters of

those words. The words were: shines; shining; shade; shadow; and dark. I asked the students to read them with me. Next, I had them take turns reading the story by characters. After they finished reading the story, I asked them questions to check their comprehension. The students were very good in answering the questions. Afterward, each student was given a work sheet and they were to fill in the blanks with the appropriate words that were listed on the board. I read each sentence and let them give me the vocabulary word which they thought made sense. I found out that they had a hard time recognizing the sound of the beginning cluster such as "sh" and "st"....We had fun together, and we will read another story on the next Monday.

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8:17) Darlene
I have five third grade girls in my reading group. I feel fortunate that I already know a majority of the girls because I am teaching out of my home with my sister and her neighborhood friends. I was really nervous before my first lesson, because I wasn't sure how excited the girls were going to be; but the girls were filled with excitement....I first started by telling them a little bit about my overall goals for the next several weeks. I wanted them to feel comfortable on this first day so I had several books for the girls to choose from that they wanted me to read. I read two short books, "The July Bear" and "The Hating Book." After, each book we discussed a little about their likes and dislikes of the stories and how they could relate to the characters. After we were done reading I had the girls make their WORD BANKS. They loved them! I supplied the containers and allowed them to decorate them with stickers crayons and pens. We then put in three new words we learned from the stories we had just read. I know they enjoyed the WORD BANKS because I talked to many of the parents a week later and they kept commenting on what a cute idea the WORD BANKS were. From now on the girls are to bring their WORD BANKS every week and we are going to play various games with them at the end of each lesson. I really enjoyed teaching my first lesson. It was challenging since many of the girls already knew me; I had to make sure that they were staying on task on not just using the time to visit. I'm looking forward to teaching my next lesson.

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8:21) Chelsea
I went to Kohl school and met Tiffany and her 3-4-5- grade class. I must say that they are very cool and so is the rest of the school! Anyway, after talking with her we decided I would work with a group on putting together a book on Indians, I was very stoked and couldn't wait to go back. On Monday I went back and she set up a group of six kids for me to work with, all at different levels of reading and writing capabilities. We broke this group into 2 smaller groups and I read each group an Indian legend ("The Legend of the Bluebonnets" and "The Legend of the Paintbrush") and then we outlined the story together so they could rewrite the story for me to put in the book. The first group really got into the story from the beginning so I was feeling pretty good as I took on the second group. Group number 2 came and just sat there and looked at me! Not quite panicking totally, I just started reading and then set about getting them to help me outline. As soon as I started asking them about the legend— whoosh — watch out! These guys just busted out and took off! It was so cool! Tomorrow I'm going back to help them finish up their stories and I think next week we are going to start in on Indian poetry.

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8:46) 12-NOV-92 17:06 Michelle
Last Thursday, October 29th, we worked on a word map and completed our story. It was a very rainy day and they had no electricity. Also, they had a substitute. The kids were very hyper and the sub looked like a lost puppy. We had no lights and I had a bad headache, so the lesson didn't go as well as I would have liked. We did a word map with the word "peace". The boys weren't really interested in this as much as the girls were. The boys tended to joke around more. The girls were more serious. Since, I wasn't feeling well, I just let it go. But, I know now that I should have tried to pull them all in a little harder. Otherwise, I got some great input and the kids put some thought into it. Then, we finished our story. We had two chapters and they got bored with it. So, they ended it. But, it turned out pretty well. All in all, considering the circumstances, it wasn't so bad..

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8:47 Sue Eskridge
Michelle, what do you think you could have done to pull the students all in?

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8:48) Michelle
I think if I had taken more time to individually question the boys with specific questions about their thoughts on the concept of "peace" it would have been better. Today it did go better....

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Feedback from students indicates that they find the teleconferencing both fun and helpful. Following are some typical comments.

Item 15 Peg Langer
Improving Teaching Effectiveness
...add a few comments regarding your reactions to working with the telecommunications network this semester.

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15:4) Sally
I think it is a great idea—I have met some new people and it has provided me with a great way to get in touch with certain hard to reach people (like Dr. Eskridge)—it has also saved paper since we would have done all of this in learning logs—I have really enjoyed using this!

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15:24) Jennifer
This has really been fun! It has helped me to think through things more and seeing what everyone else is doing is interesting. Gives me a lot of ideas. Also, I was really a blank about

computers before this—now I feel like I know a lot and will be able to use them when I teach.

- - - -

15:25) Mark

I like using the computer to stay in touch because I can always log on a few minutes and get psyched up reading about what is happening. I get good ideas and it's really easy now that my roommate and I have a modem—I can do it from my room any time I want! I plan to stay on (if possible) when I student teach.

- - - -

Student feedback confirms that use of a computer-assisted conferencing system in pre-service teacher education classes is appealing to prospective teachers. The conferencing allows for more extensive and thoughtful sharing of ideas than is possible within the typical time frame of classes. Using computers instead of individual logs or journals allows students to share ideas with peers in a meaningful manner as opposed to merely recording events for the instructor. Furthermore, students who have participated in computer conferences in their teacher preparation coursework will be more prepared to use computers in their own classrooms and will have ideas on how to infuse technology into the curriculum.

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911 for student teachers

Mary Ella Lowe
Stephen F. Austin State University

Teaching is a demanding task. It is especially difficult during student teaching and initial practice. In an effort to assist students in making the transition from novice to experienced professional, "Dial-a-Teacher" was implemented. This was a computer network that linked student teachers with elementary education professors by electronic mail. The system was implemented in the Fall of 1991 and continued throughout the Spring of 1992 with different schools and student teachers.

The majority of our student teachers are placed in public schools geographically distant from the university and it is quite common for a school to have only one or two student teachers at the same time. This isolates these students from other student teachers as well as the university. "Dial-a-Teacher" provided extended contact and support in an effort to increase student teacher morale and confidence.

The participants in this project were 48 preservice teachers in seven different school districts. Those districts outside the immediate university area that had the largest numbers of student teachers were invited to participate. All were enthusiastic in agreeing to be a part of the project. One elementary school was identified by the district as the host school where equipment would be available for student teacher use of "Dial-a-Teacher."

Program Design

The necessary equipment needed to make the system operational in each school consisted of a computer,a telephone, and 2400 baud internal modem. The university provided the modems and assistance with their installation. The computer used in the Elementary Education Department was a Packard-Bell XT design, MS-DOS. Software selected for the program was Mustang Software's WILDCAT system. This was chosen because of its features: multiple levels of access security, ease of initial set up, its ability to fully customize the interface and menu screens, and the level of technical support offered from Mustang Software.

Since all elementary students are required to take a computer course as part of their general education program, it was decided that no computer training is necessary for the participants. Orientation to the program was scheduled in two-hour sessions over a course of three days. These sessions consisted of explanations and the basics involved in using "Dial-a-Teacher." Each campus required a slightly different procedure to gain access to the program due to the variety of computers used. A detailed guide was developed that included each unique entry. This was given to each participant and placed at each computer terminal.

A letter explaining "Dial-a-Teacher" was sent to each supervising teacher assigned a student teacher. The letter explained the project and asked them to encourage the student to use the system at times that would not conflict with their observation and teaching responsibilities. These times were after school, during lunch time, music or physical education.

The main menu of the system allowed the students to make selections depending upon their need. They could choose to send or read messages, check the files or view the calender of university and community events. Students were able to communicate with faculty and their university supervisors through me. This meant the expertise of many professionals was as near as the telephone. This made it possible to answer requests for assistance by the next day, if not earlier. Students could also send messages to other student teachers in the project.

Files were available for the subject areas Reading and Language Arts, Social Studies, Science and Math. These contained a variety of lesson plan ideas for various grade levels. There was also a file of classroom management ideas that ranged from behavior modification to assertive discipline.

Many of the messages received from the student teachers requested help with lesson plan ideas on specific topics or certain kinds of individual discipline problems. There was also a request of where to find or how to make a type of modeling clay students could mold by hand. Some unexpected and very special messages told us how much they "loved teaching," that they passed the ExCET exam, and they had a job! It was always exciting when they logged on to the system just to say "hello" and that things were going well.

Results

Just as all new ventures have problems, "Dial-a-Teacher" had its share. Due to unforeseen technical and mechanical problems, the project was not completely operational at all sites for the length of time originally planned. Who could have anticipated that rain would create so much static in a telephone line in a rural school that the computer messages would be garbled until the line has time to dry? In spite of this, student response was exceptionally favorable. Some comments from a follow-up questionnaire in response to the question of benefits to student teachers were as follows:

1. "You do not feel so alone."
2. "Lesson plans, security, research."
3. "I knew there was help when needed."
4. "Just a shoulder to lean on and knowing a helping hand was available was nice."
5. "A link with the university and the calendar of events at the touch of a button."
6. "Access to the University and all of its resources."

These participants obviously found the computer network user friendly and comforting.

Recommendations:

A follow-up survey asked students for their recommendations. The major one was to have a computer, modem and telephone link-up at *each* school that had student teachers. Traveling to another site after school proved to be inconvenient and limited usage of the system as most schools are vacated and locked by 4:00 P.M. This fact had not been considered in the original planning.

Another suggestion was to have more initial instruction and "hands-on" practice in the use of "Dial-a-Teacher." Only half of the participants felt the required computer course they had taken was sufficient to prepare them in using the computer. They did not see themselves as being computer literate after taking the course.

The student teachers also said the availability of a printer would be appreciated. It takes time that preservice teachers do not have to copy information from the computer screen.

Eighty-one percent of the participants said they would like to be able to communicate directly with other student teachers and *all* of them said they would definitely use a similar system if available to them as a beginning teacher. Seventy-two percent of the 225 preservice teachers who were not involved in the project said they would have used the system had it been available to them.

Providing assistance and support to students in partnership with the public schools was the purpose of this telecommunications system. However, there were also positive outcomes for the elementary education department. These included:

1. Increasing faculty awareness of student teacher concerns.
2. Supplying information for departmental curriculum needs.
3. Providing necessary data for evaluating the department's preservice preparation program.
4. Providing experimentation with the use of technology for teacher preparation for the enhancement of students' chances for success and future professional growth.
5. Providing the vehicle by which this university could move into the state mandated "induction year" for beginning teachers.

Discussion:

This overwhelming support of "Dial-a-Teacher" signifies there is a need for programs of this nature in teacher preparation programs. Students have greater confidence in teaching because of added support from faculty and this improves teacher effectiveness and chances for future success and professional growth.

Telecommunications can provide these beginning teachers educational opportunities not previously possible (Schrum, L., 1992). It can also make the transition from novice to professional much easier. Increasing numbers of computer network projects that connect student teachers or beginning teachers with university sites are emerging as network technologies mature (Brooks and Kopp, 1989).

Teacher educators have a professional responsibility to experiment systematically with applying existing and emerging technologies to teacher training if preservice teachers are to be successful in the 21st century. Senate Bill 994, passed by the 70th Texas Legislature, requires "universities to be partners with public schools" in providing induction programs for beginning teachers. It is also probable that with the increased contact and support of the university and the public schools during the preservice as well as the induction year, the statistic that thirty percent of beginning teachers leave during the first two years of teaching and more than fifty percent leave during their first four years (TEA, 1989) will no longer hold true. We simply cannot afford to lose these capable and effective teachers for our children—they are our future.

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The integration of telecommunications into special education student teaching

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Introduction

Technology has become an integral part of most teacher education programs. Yet, the student teaching experience provides a unique challenge in the area of technology integration. Many student teachers experience a sense of isolation as they leave the university environment and begin their field experience. Not only do students leave the familiar surroundings of the university campus, but they are no longer in direct contact with peers or faculty that might serve as a resource during their student teaching experience.

At Gonzaga University a pilot project is underway that will utilize electronic mail as a conduit for communications among and between student teachers, university supervisors, teacher education faculty, and participating classroom teachers.

Clearly there are numerous aspect/dimensions to a special education student teaching experience. We have chosen four of these for examination in this study. These dimensions of the student teaching experience were chosen based on their systemic impact on the teaching experience. The variables chosen were:

1. anxiety in student teaching
2. confidence in the use of technology
3. self-efficacy in special education student teaching
4. reflective thinking in special education student teaching

It is hoped, as this project gets underway, there will be a decrease of anxiety in student teaching, and an increase in confidence in the use of technology, self-efficacy in special education student teaching, and reflective thinking in special education student teaching.

Characteristics of the Special Education Student Teaching Experience

Student teachers experience many challenges as they leave the university and head for the classroom in which they now will have many responsibilities. Student teachers are aware of the leap they make from university to the classroom and have concerns about their competencies in many areas of student teaching. "For student teachers, lowest self-competence ratings were given to knowledge of specialists, procedures, and referral sources for exceptional students, skills for working with parents, understanding of standardized test data on cumulative records, and knowledge of school law" (Dastoli, 1987). The areas of concern for student teachers are clearly areas in which the special education student teacher will need to function effectively from the beginning of the student teaching experience. Special education student teachers must be competent in many areas, including: "assessment, planning, instruction, behavior management, consulting, and administrative skills" (Gable, 1992). Encouragingly, Peterson & Hudson (1989) found that increased collaboration, communication and support among the parties involved in the student teaching experience, "helped ensure that students would apply recently learned skills to classroom settings." The incorporation of electronic mail is believed to have potential for facilitating increased collaboration, communication and support among those involved in the student teaching experience. New approaches to structuring special education student teacher experiences have begun to emerge (Shea, 1990) that focus on examining the roles of all those involved. The incorporation of technology clearly has the potential to facilitate many positive outcomes of student teaching, especially in special education.

Reflection in Student Teaching

Reflective thinking in the student teaching experience is an important component of "enhancing the student teaching experience as a shared occasion for personal and professional growth" (Krutilla & Safford, 1990). Many efforts are underway to provide opportunities for reflection in student teaching. Grippin (1990) incorporated a weekly seminar in which students were taught about reflection. These students then were required, as a part of the student teaching experience, to "reflect upon readings, structured observations of practicing teachers, and their own planning for teaching" (Grippin, 1990). The findings of Grippin indicate that reflection in the student teaching experience can be seen as a "vehicle" for educational change and growth. A different study, in which "five special education student teachers and their cooperating teachers maintained weekly journals reflecting upon successive, prescribed themes" (Krutilla, 1990) illustrated that a structured opportunity for reflection does indeed enhance desired outcomes associated with thinking and reflecting on the teaching experience. Requiring student teachers to engage in reflective thought was also examined by Pugach (1990). The student teachers in this project were required to engage in structured, explicit self-monitoring as a mechanism to enhance reflective thinking about teaching. Pugach believed that it was "essential for student teachers to be placed in a position of having to reflect on problems of practice which are of current concern to them" and that this reflection through self-monitoring enhanced the practice of reflective student teaching. In this study, it is believed that the positive outcomes found in other research will be evident here as well, through the use of training in reflective thinking and the use of electronic mail logs for structured reflective thinking.

Self-Efficacy in Student Teaching

As special education student teachers approach and engage in the student teaching experience, their self-efficacy as a student teacher will have a significant impact on their motivation, goal setting, learning and adapting to this new experience. "Self-efficacy refers to personal judgments of performance capabilities in a given domain of activity ... and heightened self-efficacy enhances motivated learning or motivation to acquire knowledge and skills" (Schunk, 1984). Self-efficacy is also closely tied to the goals that learners set for themselves (Zimmerman, Bandura, & Martinez-Pons, 1992). As individuals come to believe they can accomplish goals they have set for themselves, motivation to pursue the goal and persist in the task is heightened. If however, a learner has little belief in his/her ability to attain a goal, then motivation decreases. "Perceived self-efficacy influences the level of goal challenge people set for themselves, the amount of effort they immobilize, and their persistence in the face of difficulties." (Zimmerman, Bandura, & Martintez-Pons, 1992). Clearly, heightened self-efficacy is a desired condition in student teaching.

Additional positive outcomes of heightened self-efficacy in a teacher include a more humanistic orientation to the learners (Woolfolk, 1990), an increased ability to appropriately influence students (Chester, 1991), increased confidence in abilities and increased satisfaction in teaching (Kemis & Warren, 1991), and greater abilities to react confrontively (rather than permissively) to students when necessary (Korevaar, 1990). Various approaches to enhancing student teacher self-efficacy include cognitive modeling and communication with colleagues about self-efficacy (Gorrell & Capron, 1990), cooperative learning, role models, and computer use (Ramey-Gassert & Shroyer, 1992). The project underway seeks to enhance the self-efficacy of special education student teachers in pursuit of many positive outcomes, some of which are presented above. Through increased communication, support, and information exchange via the electronic mail system, it is expected that the participants' self-efficacy in special education student teaching will be enhanced.

Anxiety in student teaching

There exist many areas in which student teachers experience concerns and anxiety. These include: "relationships with supervisory personnel, conditions in the student teaching setting, student achievement, assignment to student teaching, time, and adequacy of preparation and classroom management" (Morris & Chissom, 1978). Sinclair and Nicoll (1980) found that student teachers in their study experienced anxiety associated with: " fulfilling expectations, relating to pupils, relating to cooperating teachers and supervisors, and achieving lesson goals". They also found that anxiety is most commonly found just prior to student teaching or when situations arise in which the student teacher feels insecure or inadequate. Anxiety is clearly associated with a decreased ability to learn and function at an optimal level (Covington & Omelich, 1987). One explanation for this phenomenon offered by Tobias (1979) is that of interference. Tobias stresses that the anxious individual must devote a large portion of their cognitive and affective resources to managing their anxiety rather than concentrating on the task at hand. We certainly do not want student teachers to be distracted from their work by anxiety associated with the many challenges of student teaching. Research focusing on the reduction of anxiety in student teaching indicates that anxiety does seem to decrease across the span of the student teaching experience, but for the student teacher to have the support of colleagues and communication with them is helpful (Gilroy & Moody, 1976; Pigge & Marso, 1987). Having regular, easy access (via electronic mail) to other special education student teachers and university supervisors may reduce anxiety through the mechanism of enhanced support for the student teacher. This is an anticipated outcome for the participants in this study.

Confidence with Technology

A number of research studies have examined the attitudinal components that contribute to the effective use of technology in the classroom (Loyd & Gressard, 1984; Kinzie & Delcourt, 1991; Violato, C., 1989; Koohang, A., 1989; Bean, B, 1988). A factor consistently examined in each of these studies involves the teacher's, or student teacher's, confidence in their use of the technology or in the technology itself. Thus, the primary attitudinal factor examined in this study will be computer confidence.

According to Kinzie & Delcourt (1991) and Poage (1991) computer confidence can be influenced by experience with the technology, therefore the continuous use of electronic mail is expected to influence the confidence of the student teachers.

Methods

Subjects

The participants for this project were selected from a population of 26 potential candidates, all student teachers in the Spring of 1993 from the Department of Special Education. The exploratory nature of the study and the funding constraints at this initial stage of the project unfortunately precluded the inclusion of all 26. As a result of this, ten student-teachers were selected as subjects for this study on the basis of the following criteria:

a) Interest in participating
b) Student perception of value of the study
c) Either experience with e-mail or willingness to be trained in the use of e-mail.

Data Sources

Data will be collected from multiple sources. These include:

1. *Computer confidence data.* This data will be collected via *The Computer Confidence Scale*, (Poage, 1991). Selected items from this scale will be used to generate a computer confidence index. This index will be used as an indicator of the student teacher's confidence in the use of electronic mail. Example items to be used include:
   a) I know enough about computers to fix problems as they arise.
   b) If the computer doesn't work I would run and find someone to help me.

2. *Self-efficacy in student teaching data.* This data will be collected via a set of items generated according to Bandura's model of self-efficacy (Zimmerman, Bandura, & Martinez-Pons, 1992). Sample items for measuring self-efficacy in student teaching are:
   a) How well can you adapt your instructional objectives to match the emerging needs of your students?
   b) How well can you motivate your learners to actively participate in class?

3. *Anxiety in student teaching data.* Data will be collected via a set of items generated from the Worry subscale of the*Test Anxiety Inventory* (Spielberger, Gonzalez, Taylor, Ross, & Anton, 1977). Sample items for measuring anxiety are:
   a) I worry about making mistakes in student teaching.
   b) I have trouble making up my mind while I am student teaching.

4. *Reflective thinking data.* The reflective thinking data will be collected through analysis of student e-mail logs. The data will be analyzed according to the following categories:
   a) Reflection on lesson plans
   b) Reflection on the content/subject matter knowledge
   c) Reflection on teaching strategies
   d) Reflection on anxiety and stress in teaching.

The university supervisor's e-mail communications to the student-teacher will be analyzed as well. Two types of additional data will be :

a) University supervisors observations and
b) Master teacher midterm and final evaluations of the student-teachers.

This information will be used as a means of cross-validating the findings of the study.

Procedure

Initial data on computer confidence, anxiety, and self-efficacy in student teaching will be gathered prior to the beginning of the training session. Then, a training session will be held prior to the start of the student teaching experience. During the training session, the following will be addressed:

1. The student teachers will be instructed in the use of the e-mail system.
2. Guidelines for reflective thinking and use of the e-mail log for documenting their reflection will be provided for the student teachers. These guidelines will include reflecting on and writing about questions such as:

a) What happened this week (day) that worked well? Why?
b) What am I proud of in my teaching? Why?
c) What happened this week (day) that did not work as planned? Why?
d) What did I learn that will help me to be a better teacher?
e) List one specific area that needs work. What can I do to work on this area?
f) What are some questions I'd like to ask others?
g) What have I learned about myself in my student teaching?

At the end of the training session, the student teachers will again respond to the items addressing computer confidence, and anxiety. During the student teaching period, the participants will be asked to read their e-mail everyday and respond as often as they are able or see a need. Once a week, the student teachers will respond to the reflective thinking questions provided to them during the training session. Throughout the student teaching period, the data from the logs will be analyzed and communication with the student teachers will incorporate this information. This will allow the university supervisor to engage in better informed communication with the student teachers. It can be imagined that there will be common and unique concerns on behalf of the student teachers and that these will be reflected in the e-mail logs. Those of a unique nature can most appropriately be dealt with privately, and the common concerns can be dealt with publicly on the network of the e-mail users.

At the end of the student teaching experience, the participants will be asked to respond again to the measures of computer confidence, anxiety, and self-efficacy in student teaching.

Data Treatment

The data collected on the items for computer confidence, anxiety, and self-efficacy in student teaching will be analyzed quantitatively (repeated measures ANOVA).

The data from the student e-mail logs will be content analyzed by three researchers. The level of agreement among the researchers doing the analysis will be examined. The content analysis will focus on the previously described reflective thinking categories.

Expected Results

It is anticipated that after participation in this study, the student teachers will experience the following:

a) A reduction in anxiety associated with student teaching
b) An increase in computer confidence associated with using e-mail as a means of communicating with colleagues and documenting reflective thought.
c) An increase in self-efficacy in student teaching.
d) An increase in willingness to reflect on situations and issues involved in teaching and to approach these situations in better ways.

Student teachers who enrolled in the program will be more aware of problems which arise in the practice of teaching. These problems may include:

a) focusing student attention on the subject
b) appropriate pacing of instruction
c) the need for specific instructions
d) consistent discipline
e) lack of motivation to learn among some students

By using e-mail, we imagine that student teachers will be more willing to ask how they might do things differently than they might have done otherwise. Through the use of e-mail, the student teachers may be more able to consider alternative approaches to the handling of challenging situations. They will also be more likely to share their experiences with others and to benefit from being not only the giver, but also the receiver of information. This increased exposure to the student teaching experience through e-mail may result in the student teachers employing a wider variety of teaching strategies than they might on their own.

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Patterns of use of an electronic communication network for student teachers and first year teachers

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The Problem

The professional isolation of educators has long been a problem. Dan Lortie describes the "egg crate" nature of teaching, referring to the fact that typically, teachers are isolated in their classrooms and have little opportunity for interaction with other teachers and experts in their fields (Lortie, 1975). Supporting Lortie's findings, Goodlad (1983) reports that teachers are generally confined to their classrooms and are unable to converse with other educators about problems or concerns.

The isolation problem is particularly acute for new teachers. Many times, the new teachers are hesitant to ask the experienced teachers for help and the veteran teachers are reluctant to offer their assistance (Newberry, 1978). Usually, it is difficult for these first year teachers to communicate with the people who have trained them in the university. Thus, beginning teachers are often left to solve problems on their own. Lortie (1975) attacks the abrupt transition into teaching when he states, "compared with the crafts, professions and highly skilled trades, arrangements for mediated entry are primitive in teaching."

Recently, a number of colleges and universities around the country have attempted to address the problem of isolation of new teachers by establishing computer networks that link experienced educators at universities and in classrooms with beginning teachers. The experienced educators on the systems act as mentors for the beginning teachers by providing support and offering guidance on topics of concern. The beginning teachers can also communicate with each other and discuss shared problems or concerns. Ideally, the networks are designed to act as support systems for beginning educators.

PLUTO International Networking (Kurshan, 1991) is one example of such a network. It connects teachers trainers, student teachers, and inservice teachers in ten European countries.

While current student teacher networks may enhance the guidance student teachers receive from their supervisors and promote greater peer communication, Levin, Kim, and Riel (1990) specifically explore the use of electronic message systems for teleapprenticeship. Most educational activities rely on face-to-face communication. Face-to-face interactions generally follow a simple pattern of teacher initiated question, followed by student response, and end with teacher evaluation; however, message analysis of CMC produces much more complex patterns of initiation, response, and evaluation. Levin *et al.* suggest apprenticeship is one educational activity that models the interaction patterns occurring in CMC. Consequently, teleapprenticeship, instruction occurring on-line while students are in the target domain, should flourish in this new instructional medium.

Several studies attempt to isolate factors contributing to the success or failure of electronic networks. Maddux (1991) suggests networks suffering from the Everest syndrome, telecommunications for telecommunication's sake, risk early extinction when the practical problems plaguing all networks surface.

Riel and Levin (1990) examined the participant structures of successful and unsuccessful university, teacher, and student centered networks. The participant structures characterizing successful teacher communication are the most pertinent to this paper. They looked at three networks for teachers, one successful and two unsuccessful. They concluded, "Networking can provide a means for teacher learning and teacher development, but placing the technology in the hands of teachers is not likely to be enough." (p. 156). Teacher networks constructed around the following elements are most likely to succeed:

1. Conventional means of communicating, (face-to-face, phone, mail) must be viewed by the participants as inefficient for group interaction.
2. A goal or task needs to be shared by the group.
3. A coordinator needs to take the responsibility of facilitating the interactions.

Feenberg and Bellman (1990), like Riel and Levin, stress the importance of addressing the needs of the participants in the design of a successful network. The power and complexity of the software used to access the network must by geared to the needs and proficiency of the participating group. Supportive documentation and training must produce users confident in their ability to access and tap the power of the network. Conference architecture needs to accurately reflect group interests and skilled moderators need to effectively coordinate conference participants toward a goal.

Although electronic networking appears to be an obvious solution for many of the professional communication problems of new teachers, many networks constructed for this purpose have failed. There is a need for studies characterizing the use of such systems so that systems may be designed and updated with users' needs, habits and desires in mind.

Objectives

The objective of this study was to describe usage patterns of an electronic communication system designed to facilitate professional communication for new educators and to determine if this use does benefit the induction process for this group. The study is descriptive in nature.

Methods

The College of Education at Iowa State University is currently pilot testing three electronic network systems for educators and has been gathering data on the use of these systems. The initial system was established in Fall, 1988 and is designed for student teachers from the university. On this system, student teachers can communicate with other student teachers, Iowa State faculty, and experienced teachers. A similar system was set up simultaneously for first year superintendents in Iowa; this system includes the first year superintendents, Iowa State faculty in Educational Administration and selected experienced superintendents. In the Fall of 1989, selected first year teachers in Iowa schools were added to the existing student teacher system. Similarly, new student teachers are given instruction and added to the system each semester and first year teachers are added each fall. In May, 1992, there were approximately 172 active users on the system.

In addition to connecting new educators with faculty expertise, the network is designed to make experienced classroom teachers available to the novices. The three-pronged approach is designed to help link College of Education faculty to the world of practice, as well as to make their expertise available to new educators. Ideally, faculty, experienced teachers and new teachers all have the opportunity to interact on areas of concern for the new teachers. Certainly, each participant in such a discussion should be learning from the perspective of the other.

A system operator works 20 hours per week to maintain the system, ensure that messages are answered and train new users of the system. In addition, the system operator initiates conferences for special interest groups on the system.

Data for the study were collected over the 1991-92 academic year and will continue to be collected each semester of the 1992-1993 academic year. Data were and will continue to be collected from the system log and from questionnaires administered to student teachers and first year teacher users of the system. There were 152 elementary and secondary teachers using the system during the 1991-1992 academic year; approximately the same number of users will be included in the first semester 1992-1993 group.

Preliminary Results

Since the study remains in progress, results summarized here are preliminary and subject to modification as new data are collected.

In general, users were positive about the system and indicated a desire to use the system the following year. New educators, faculty members and experienced teachers cited opportunities for professional communications and connections as the most useful aspects of the system.

Student teachers who had supervisors on the system were more likely to use the system than student teachers who had supervisors who were not on the system and/or did not use the system frequently. Student teachers who had supervisors who used the system frequently also had significantly more positive attitudes toward technology use in classrooms after their experiences than before the system.

Previous computer background is a strong predictor of the amount of use a student will make of the system. Heavy users of the system differ significantly from light users on this dimension.

The average system user calls the system about once a week and remains on for about 9 minutes. Peak usage times are from 3:00 p.m.- 5:00 in the afternoon and from 10:00 to 11:00 at night. First-year teachers and student teachers interact most frequently with each other and the second most frequent interactions are between the new teachers and Iowa State University College of Education faculty.

The most common topic of communication for the new teachers was on general educational issues, followed by technology issues and classroom management issues. Specific curriculum issues were the least frequent topic. The most common topic for student teachers was scheduling of meeting times with supervisors.

System use was the heaviest in the middle part of the week and lightest on weekends. During a weekday, use was heaviest before and after school and in the evening between 8:00 and 11:00.

Private messages outnumbered public messages by a ratio of 1-8; use of public messages increased, however, as each group of new users became more experienced on the system and as the system operator generated topics and conferences in this area.

Significance

Data from this study provide information on use patterns for an electronic communication network designed for student teachers and first year teachers. This information should be valuable for researchers attempting to understand evolving uses of such systems and for educators currently establishing and implementing these systems.

Some of the results reported here provide direction for possible interventions to facilitate the use of these systems to encourage professional communications opportunities for new educators. Results suggest that new teachers were most comfortable using the system to communicate with each other. Interventions to encourage interactions with more experienced educators should be implemented and studied.

Although public mail offers possibilities for more group interaction and a different type of communication, our results indicate that this type of communication requires some basic experience on the system and intervention on the part of the system operators. The public mail capabilities of the system offer a different type of communication for users, but users need encouragement and support to learn to use this capability.

It is interesting to note that the least frequent topic of communication for the new educators was specific classroom curriculum issues; one of the major reasons for creating such a network is to provide support for beginning teachers in this area, yet it seems evident that some intervention is necessary to make this topic a vital part of the system. It is also possible that more sophisticated and content-oriented discussions will occur on the system as users become more experienced.

For the student teachers, the involvement of their supervisors on the system was a significant factor influencing their own use of the system. The students who had supervisors who were active users of the system also showed a significant increase in attitude toward the importance of technology in education after their student teaching experience.

It seems clear that electronic communication networks offer possibilities for improving the professional communication possibilities for classroom teachers and teacher educators; it is equally clear that researchers need to understand evolving use of these communication systems in order to maximize the potential of the communication possibilities. Our data indicate that specific interventions are necessary to maximize potential capabilities of an electronic communication system for teachers.

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Breaking down barriers through telecommunications

Michael J. Rush
Project INSITE

Introduction

In our highly technological information age, many skills, abilities, and points of view are needed in order to accomplish the task of educating students for the next century. Students need to learn how to collaborate, find solutions to problems, analyze information, and communicate their ideas effectively to others. Project INSITE provides opportunities for students to share interdisciplinary projects, designed cooperatively by teachers and scientists, to improve critical thinking, problem solving, and communication skills.

Project INSITE is a five year $500,000 grant funded by the National Science Foundation and the Indiana Department of Education to improve science education through the integration of information technologies in grades three through twelve. INSITE is a partnership of seven Indiana school districts, the Indianapolis Zoo, the Indiana Cooperative Library Services Authority (INCOLSA), DIALOG Information Services, Inc., and scientists from Lilly Research Laboratories, Marion Merrell Dow Research Institute, and Purdue University. The project focuses, specifically in on-line retrieval, electronic mail and electronic bulletin boards. Over 200 teachers and approximately 12,000 students are involved in the project.

The five key elements to the success of this project are: school district commitment to the process, teacher inservice, curriculum development, ongoing technical and instructional support, and the active participation of scientists.

Teacher Inservice

Technology can dramatically enhance the instructional process if teachers are made aware of the possibilities, learn how to use the technology effectively and creatively, have the instructional materials needed to integrate the technologies, and are given the support to effectively implement their ideas. Teachers must first have a true understanding the technology they will be using. Project INSITE has created a comprehensive two-week teacher training program involving basic on-line education, staff development, and the creation of curriculum materials. Initial training focuses on the basic technical skills relating to the use of computers, modems, and telecommunications software. Teachers then learn how to conduct on-line searches, mail messages electronically, and post and receive messages on an electronic bulletin board. Major emphasis is placed on the understanding of the search process, the types of databases included in CLASSMATE, and how IDEAnet is used to connect with scientists. To assist potential adoption sites, the project has created a twenty page teacher inservice manual that outlines a step-by-step process for conducting the training.

Project INSITE has developed an effective inservice model which provides new teachers to the project with basic technical skills; gives them a philosophical and instructional basis for the use of information technologies; and assists teachers in creating student projects which focus on real world issues and include a link to outside sources, namely scientists, on-line database services, and other students. Concomitant with the inservice model is the development of an articulated integrated science curriculum which provides students with the opportunity to participate in real hands-on science; gives students access to information technologies; incorporates a learning environment that encourages exploration, collaboration, and experimentation; and provides students with the opportunity to establish a rapport with practicing scientists.

Curriculum Development

Acquiring basic technical skills gives teachers the ability to begin planning how they will apply telecommunications in their classrooms in order to support student acquisition of science process and content skills. Beyond technical skills is the critical need for teachers to understand the importance of information processing (acquiring, analyzing, using, evaluating, and combining data) as a necessary skill for the 21st century. Once the technical skills are learned, teachers can begin to gain a conceptual understanding of how information technologies can be effectively and creatively integrated into their classrooms to support and expand the curriculum. Teachers begin to see how their students can use the technology to reach beyond the traditional school boundaries to acquire information and share their thoughts with others. As a part of the inservice training, teachers develop a series of comprehensive student projects which have as their foundation the use of information technologies. The private sector partners, which include scientists from Lilly and Marion Merrell Dow, are an integral component of this inservice. During the past three years, the participants have created over 75 student projects which employ on-line database searching, focus on societal issues, incorporate collaborative inter-school activities and include substantive contacts with scientists.

Technical and Instructional Support

Technical training and materials development are only the beginning. It is essential that teachers have the support necessary to try new ideas and use unfamiliar technologies. A large number of teacher workshops do not have a major impact due to a lack of support once the teachers return to the classroom. Small technical problems become large nightmares which are impossible for the novice to solve. Teachers return to the path of least resistance and much of what was learned is not put into practice. To ensure against this, Project INSITE has built in an extensive support system which includes ongoing training, routine visits to classrooms, and an electronic link to technical and curricular experts. Teachers are visited on a regular basis and are kept abreast of project activities through a project-wide newsletter. Giving teachers this support mechanism has greatly increased the overall success of the project.

Participation of Scientists

Many teachers are overwhelmed with the amount of available scientific data, the enormous advances taking place on a daily basis, and the need for their students to become scientifically literate. Two database services (CLASSMATE and IDEAnet) provide an opportunity for students to acquire new and pertinent information and to communicate with individuals who are involved in various fields of science. Scientists from Lilly Research Laboratories and Marion Merrell Dow Research Institute assist teachers as they create student projects. As those projects are implemented, students conduct experiments with students in other schools, share and evaluate data, contact scientists for assistance or respond to questions posed by scientists, and conduct on-line research on real world issues and topics.

A major thrust of the project is to provide students with a viable communications link which can be used to share their experiences, provide support, and expand their horizons. Students are given a better understanding of how science works and what is involved in various science occupations. Scientists play a key role by providing insights into what it is that scientists do, providing information on new research, guiding students in planning experiments, and acting as mentors to both teachers and students.

The combination of education, support, connectivity, and ability to search vast quantities of information for almost any conceivable topic brings new hope to teachers for developing classrooms which are responsive to the needs of students in the information age. Through contact with scientists and other students, telecommunications has the potential to instill a sense of wonder and desire for exploration and discovery, promote a pro-active student learning process, and expand the ability of our schools to improve science education.

Project Evaluation

During the summer of 1991, 38 teachers and other school personnel took part in Project INSITE training activities in preparation for the 1991-92 school year. Thirty-one of the participants worked at the elementary school level, while five worked at the middle school or junior high level, and two taught at the high school level. Four of the participants were pre-service teachers who

Table 1
Pre- and Post-Test Results for Training Participants

Measure	Pre-Training Mean	Standard Deviation	Post-Training Mean	Standard Deviation	Gain	t-value	Prob of t
Computer Attitudes	84.27	8.15	86.08	7.52	1.69	2.24	.0314
Content Knowledge	2.95	2.78	11.68	2.27	8.74	15.96	.0001

Table 2
Pre- and Post-Test Results for Students

Measure	n	Pre-Training Mean	Standard Deviation	Post-Training Mean	Standard Deviation	Gain	t-value	Prob of t
Computer	360	81.19	9.58	81.40	11.53	0.21	0.41	.6801
Information Access Attitudes	323	40.76	5.35	40.73	6.40	-0.02	-0.06	.9470
Content	368	3.02	2.46	10.79	4.13	7.77	31.72	.0001

would do their student teaching during the academic year. The remaining participants were practicing teachers with a range of one to 24 years of experience. The average participant had about 11 years of teaching experience.

To assess the effectiveness of the training activities, participants were pre- and post-tested using several instruments. These included measures of attitudes toward computers and content knowledge. Attitudes toward computers were measured by means of a 20 item Likert type scale adapted from the work of Anderson and others (1979). Individual items were scored by awarding five points for strongly agree, four points for agree, three points for undecided, two points for disagree, and two point for strongly disagree on positively worded items. Negatively worded items were scored in reverse fashion. Scores on individual items were summed to yield a computer attitudes score of 20 (very negative) to 60 (neutral) to 100 (very positive). The content examination consisted of 15 multiple choice items, with five alternatives each, derived from the training content and developed by one of the authors. Identical forms of both instruments were used for the pre- and post-tests.

The results of the pre- and post-testing of the training participants are shown in Table 1. On average, participants entered the training with positive attitudes toward computers (mean = 84.27 out of 100) but relatively little knowledge of the specifics of the training content (mean = 2.95 out of 15). The post-tests showed gains on each measure that were statistically significant ($p < .05$) as determined by a paired samples t-test. Therefore, the training had the desired effect of improving participants knowledge of computer telecommunication and their attitudes toward computers. In addition, the great majority of participants reported feeling more confident, more inclined to use the computer in instruction, and anxious to engage in Project INSITE activities with their students. Participants' evaluations of the training itself were also very positive.

During the 1991-92 school year, the Project INSITE activities developed by the participating teachers were implemented in their classrooms. To get an indication of the impact of these activities, students in the participating teachers' classrooms were also pre- and post-tested using measures of computer attitudes, information access attitudes, and knowledge of telecommunication content. The computer attitude measure consisted of 20 Likert type items similar to the one used with the participating teachers. The information access attitude measure consisted of ten Likert type items related to students' attitudes toward accessing information (e.g. "I like to learn things from books and magazines"). It was developed by one of the authors. As with the computer attitudes scale, this measure was scored by summing the reaction scores of the individual items. Finally, the content knowledge measure consisted of 20 multiple choice items related to telecommunication and on-line searching. Measures were administered by the classroom teachers before and after Project INSITE activities. In addition, students and teachers were asked to complete evaluations of project activities following the use of those activities in the classroom.

Table 2 shows the results of the pre- and post-testing of the students. Although pre-test data were obtained for 368 students and post-test data were obtained for 432 students, the data in Table 2 reflect only those students for whom both pre- and post-test results were available. As these results show, there were no changes in the student population on either the computer attitudes or the information access measures, although the students on average showed positive attitudes on both measures on both the pre-test and the post-test. Thus, there is no evidence that project activities impacted either students' computer attitudes or their attitudes about finding information. However, as might be expected, there was a statistically significant ($p < .0001$) increase in students' knowledge about project content as a result of the project activities.

Despite this success, the post-test mean on the content test appears somewhat low (mean = 10.79 out of 20). Two factors contributed to this low score. First, the content examination covered a full range of project content—basic telecommunication concepts, electronic mail, and on-line searching. A number of classrooms did only electronic mail or only on-line searching. Therefore, students in those classes would not have been expected to be able to correctly answer all of the items. Second, a large proportion of the classes were elementary level, and a number of the questions were probably too difficult for elementary students. Therefore, the post-test results were not unexpected.

In addition to these results, both students and teachers completed evaluations of the project activities after their use in the classroom. The student reactions were almost universally positive. Over 80% of students agreed that they learned a lot about using the computer to find information. Over 77% reported that they really liked the Project INSITE lesson. Almost 70% of students agreed that they would like to have more activities like these in their classes.

The teachers were also generally positive in their reactions, although they were also able to identify problem areas. Nearly 77% of teachers agreed that their students liked the Project INSITE lesson. But only 64% thought that the unit worked well with their students, and even fewer, 56%, thought that their students learned a lot from the lesson. The elementary level teachers, especially, felt that some aspects of computer telecommunication and on-line searching were too difficult for younger students. Although things generally went well, about 40% of teachers reported experiencing technical problems. The biggest single problem area was limited access to equipment and telephone lines. Over 64% of teachers felt that more hardware would have improved the success of the activities. Despite these difficulties, nearly 70% of teachers felt that the Project INSITE activities benefited their students.

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Project INSITE is funded through the National Science Foundation.

Distributed schooling: A model for computer network-supported teacher education

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Distributed Schooling

Research has suggested the importance of educational change aimed at addressing needs of learners in the information age (Hunter; 1991). With the promise of access to powerful information resources such as the National Research and Education Network (NREN), there is also a need for school work to "include primary information sources so that students are simultaneously learning the critical content while gaining first-hand experience with information sources themselves" (Newman, Bernstein, & Reese; 1992). Many researchers report possibilities for conducting such first-hand instructional activities between students and teachers separated by time and distance with the assistance of electronic networks (Levin, 1990; Levin, Waugh, Chung, & Miyake, 1991; Stapleton, 1991; Stapleton, 1992; Waugh & Levin, 1988). But what strategies can be applied to increase participation in these activities by beginning and experienced teachers enrolled in teacher education courses? The following study reports on an approach that addresses this question.

On-line Teacher Education Course

A course for teacher educators was established at a state university. It was aimed at teachers in remote areas who were interested in pursuing advanced degrees and training in teacher education. During the beginning of the course, students met on campus one to two times for a few hours. They received an introduction and overview of the class and assistance on how to configure their computers with the hardware and software required to communicate on a school-based nationally linked network.

Students also learned how to carry out routine tasks such as starting up their computers, logging onto the network, reading, composing, and sending electronic mail messages, and logging off the network. System operators for the network attended one such class and discussed and demonstrated typical tasks and duties of various types of users (system operators, activity participants, activity contributors, and activity coordinators). These system operators were employed as full time graduate assistants in the College of Education at the university.

Students were assigned reading materials and required to participate in discussions to provide a background and framework needed to understand the applications, potentials and limitations of networks as applied to teaching and learning. Resources and materials that they had access to include: instructional telecommunications simulation software, videotapes, journal articles on keys to successful instructional telecomputing and a text entitled: *The Compete Handbook of Personal Computer Communications* (Glossbrenner). Students were required to keep weekly logs of their use of the network while they integrated network instructional activities into lessons at their respective schools.

In addition to assigned readings students were required to demonstrate knowledge and skills of educational networks by completing a major class assignment. They were to participate in a network activity or create and implement an original activity with their elementary or secondary school students. Students and the professor conducted the remainder of the course on-line. They did not meet face-to-face again until the end of the semester.

While some students participated in network projects proposed by others on the network, many chose to create original learning projects around their content areas. The following example, "Weather Holidays Project," is an original project created by a student who lived out of town and was enrolled in the university course. It outlines typical strategies used by the students to integrate network learning activities into their classrooms.

Purpose

The purpose of the study reported here was to investigate strategies used by practicing and beginning teachers isolated by distance to use a network to participate in a teacher education program.

Method

Educational activities were selected which were conducted by course participants on a nationally and internationally linked network used by thousands of teachers and students. They were then analyzed to address research questions. Several methods were used to select successful network activities and to collect and analyze data on those activities.

Sample

Students enrolled in teacher education courses supported by a grassroots school-based electronic network between January 1989 and June 1990 were selected. These students completed network-based instructional activities that were judged as successful by editors of a mediated electronic bulletin board on the network designed for publishing electronic reports of successful network activities.

Data Collection

The data for this study consisted of electronic mail messages exchanged on the network as well as diaries of network usage and telephone and face-to-face interviews with students in the course and key participants of their network activities.

Data Analysis

Each network activity was described along several dimensions including purpose of the activity, origin and formulation of the project idea, overview of the activity, organization of the activity, context and resources, implementation of the activity, problems of the activity, and recommendations for improving the activity.

Results/Discussion

Overview of the Weather Holidays Project

The Weather Holidays project was an educational activity successfully implemented in 1989 on the network and was also referred to as the Snow Days project. The project was targeted at a large and diverse audience. Participants used the network to exchange data about weather related school holidays. The project lasted for four months: from February until May.

Purpose of the Weather Holidays Project

The purpose of the project was to collect data from other network users about school holidays that were caused by the weather. Another purpose was to learn about other school systems and how they handled weather-related disasters. The project was designed as an activity for expanding the horizons of students at partner schools.

Origin and Formulation of the Project Idea

The teacher got the idea for the project when she was discussing the electronic network concept as part of her computer literacy discussions with her students at school. She was able to connect to the network a number of times during class and demonstrated the bulletin board system to her classes. The host school where the teacher taught was a kindergarten through fifth grade school. The idea for the project originated when the host teacher and her class had their own snow day. She talked to her students about the crisis and they responded to the crisis by discussing it. She reported that students were aware of snow holidays, since they recently had a snow day, but they were not aware of mud slides and earthquakes that happened in other parts of the world.

Around the time of the snow day holiday there was a major earthquake in California and it was also discussed. At the time of the earthquake the discussion became an idea for a network project on various weather holidays that kept students away from school. It was a spontaneous idea that originated at a time when the teacher was required develop an idea for a network project for the networking class she was taking at a local university. The teacher's idea was to have her class use the network for gathering information. She also used the network to communicate with her professor and classmates.

Participant Recruitment

In order to advertise the project and recruit participants, a call for collaboration was written. It was short, simple, and somewhat unstructured. The teacher uploaded the proposal message on two of the network's bulletin boards. One bulletin board was targeted at children and the other had an audience of educators. Students were told that the message was posted to recruit project participants and contributors. They were excited and anticipated responses from interested network users. Below is the message sent on the network to invite other teachers and students to contribute to the project.

To: PROJECT IDEAS Bulletin Board
From: HOST-TEACHER
Sent: 02/22/90 4:45 PM
Subj: SNOW DAYS OR . . .

Here in Illinois, we recently had a "snow day." It would be interesting to hear about "weather holidays" from school in other parts of the world. What happens to school days in places where there are earthquakes, and for how long is school cancelled? How do they make up the time?

What about Hawaii, during times of volcanic activity, or in other parts of the world during violent types of weather. How does the weather affect the school children and how is the school time made up? We have tornado drills in Illinois. Are there hurricane drills, or earthquake drills, etc. Answers to these questions, along with interesting experiences would be of great interest to the children in my school here in, Illinois. Please respond to HOST-TEACHER. Thank you.

Feedback and Participant Reasons for Interest in Project

Participants responded because they were interested in global awareness, and similarities and differences in schools both regionally and globally. They hoped to able to read and share diverse reports of weather holidays contributed by various respondents.

Many different answers were sent to the host class during the duration of the project. They received many responses from different sites (California, Illinois, North Carolina), describing schools being called off for mud days, earthquakes, ice storms, extreme cold, hot days, and Hurricane Hugo. The teacher responded to each answer from participants with a thank you message for responding. Following is a message received on the network from a distant respondent.

To: [TEACHER]
From: [Student]
Sent: 03/14/90
Subj: reply

Here in North Carolina (Raleigh), we have tornado drills and fire drills. During a tornado drill, the administrators blow the loud air-horns to signal teachers to take the students out into the hall. The fire drill signal comes over the intercom as a siren type sound, and all the classes go to their designated area outside. We got out in November for One day for Hurricane Hugo (even though it really did not affect Raleigh that much [just rain mainly and wind]). They (the school system) will just add a day on to the end of school to make it up. We also get out for ice or snow storms. We have had one or two days cancelled this year, and they were tacked on to the end of the year. Last year, however, we got out for about 1 1/2 weeks because it was so icy! One other time we get out of school is if (the temperature) gets over 95 degrees! That's hot down here, especially with all the humidity. Usually what happens with a 'heat dismissal' is that the school system will decide to let the students out AFTER lunch, therefore, then count that day as a regular school day, and we don't have to make it up. I hope that I have answered your question and that it will interest students in Illinois.

[Student] [School]
8th Grade, Raleigh, NC

Organization of the Project

The project did not require much organization by the teacher nor did it appear to need much organization by participants. Participants contributed simply by responding to the questions in the proposal and exchanging the responses with the host teacher on the network. Once the messages were exchanged on the network all participants had access to them.

Context and Resources

There was a small computer lab in the Learning Center where the host teacher held classes. Her responsibilities were to teach literature, geography, library skills, computer literacy, word processing and keyboarding to students. Each class had about twenty-five students. Though some students used the computers, they all were not able to get on the computers. While teaching the topics above the teacher integrated computers and The network into classroom learning activities. Every class in the school was required to have instruction in library skills at least once a week. Though every class received some exposure to computers, only second through fifth graders had involvement with the network and the Weather Holidays project.

The teacher had an Apple II GS and a modem that was provided by her professor at the local university. The modem was returned to the professor at the conclusion of the project. The teacher also had a printer in the library and used the T.I.C. (Talk is Cheap) communication software. The teacher had an assistant, but the assistant was not able to provide assistance with the network or technical problems. The role of the assistant was to check and file books in the library. The teacher implemented the project on her own. She uploaded and downloaded all of the messages and printed them once messages were composed and saved on floppy disks.

Implementation of the Project

The teacher was able to teach geography using several responses received from the network partners. She used a map to pin point places (cities) where the responses came from. She explained the process which took place when a message was sent on the network.When she got a message or response she would copy it from the network and print it. She also read the message in class.

Students participated by listening and looking at maps and reading network messages. They also observed the process of how the computer was electronically linked by telephone call to exchange information with other students and teachers outside their city. She felt that the students understood what was happening when messages were sent and received on the network. The younger students did not appear to understand the process of networking as well as the older children.

The teacher had a gifted fourth grader assisting her with the uploading and other tasks of sending and printing messages from the network. That student was able to use the computer to connect with the network successfully. The teacher trained the student how to use the network.

The teacher provided students with a printout of all responses on a weekly basis. Some of the network responses came in during the month of February but most of the responses came in March. During that time period, the teacher told students about other items on the bulletin boards that may have been of interest to their age group. The "Global Grocery List" was one such project. The teacher read students some of the "Young Authors" work from KIDWIRE. She also placed another project idea on the electronic bulletin board about the robbery cases of"Carmen San Diego."

Classroom Integration

Students were interested in the idea and made contributions to class discussions during the project implementation. The teacher discussed technicalities of earthquakes with the children. She posed questions such as, "Do earthquakes happen locally?" Students were required to do research on the topics discussed. This was an extension of the responses from the network. The class was involved in several activities, including those which involved looking for faults on the map. Even though there were accounts of the earthquake in the newspapers at the time, the descriptions from the networks were more meaningful and interesting to students because these responses were actually written by students who had experienced the earthquake. Many responses contained descriptions that were not from an adult's point of view.

The project expanded the whole lesson the teacher presented on using encyclopedias and other resources for gathering information. The teacher used the resources in the library and discussed findings with students. The project host teacher sent each person who contributed to the project a thank you message which expressed her appreciation for their participation.

Problems of the On-line Course

The biggest problem of conducting projects was accessing the network. Students often had to stay after school until seven or eight o' clock at night. They usually spent a lot of time trying to connect to the network and getting on-line to read and send messages. It was a problem during the times students called because other local teachers who also had free time after school were trying to get on-line or were already on-line. Network access was limited in that it could only allow one user at a time to be on-line. Students tried to get on-line several times during class-time but were unsuccessful most of those times. The professor assisted by posting announcements about the best times to use the network. Following is a message which illustrates this.

To: $NORTHBROOK
From: UNIVERSITY PROFESSOR
Sent: 02/08/90 9:58 AM
Rcvd: 02/08/90 11:12 AM
Subj: Usage of [Network]

Here is more info about times of logging on...

Subj: Usage of [Network]

Over the past week, the peaks of usage are between 8am-9am, 5pm-6pm, and 12noon-1pm. The valleys are between 6-7pm and 8-9pm (and of course all the hours in the middle of the night). We've been having problems with the board "crashing", so if something strange happens while you're on, please send us a note describing what it was, what you were doing, etc. so we can figure out what's going wrong.

The other problem was that the network menus and commands were very confusing. This was intimidating and frustrating when students started using the network. By posting questions to the professor and classmates on the network, and receiving solutions and practicing them, in time they got better at using the network. With this approach, sending and printing messages and similar tasks became fun and easy. However many students never progressed to a stage where they were skillful and confident in sending copies of messages to several participants (setting up conferences).

Students were able to use conferences that they requested system operators to establish for them. They noted that the process of creating conferences and addressing messages was technical and confusing. One student commented that if someone completed the required addressing and other tasks a few times then they could practice and learn the skill. However in order to retain the skill, regular usage would be necessary.

Expert Support

The university professor provided handouts and background materials about networks and networking tasks. Students commented that without those printed materials at the beginning of the course they would have been completely lost. The materials were very helpful. They were easy to read and understand without assistance from a technician or the professor.

When students did have trouble they sent messages describing the problem to the professor. The professor used the network to send messages with suggestions which usually helped to solve the problems. On occasions the professor even typed responses to questions when students were on-line. They thought that this type of real-time interaction was interesting and fun but important because of the immediate feedback.

Recommendations/Implications

Research findings suggest both face-to-face and on-line interactions can be integrated and used as a model for structuring teacher education courses. However, adequate policies and support are required on state, college and grade school levels to provide the human, technical and other resources needed for such a program. The current administration and structure of college courses and school curricula do not allow the smooth integration of network-based teacher education programs involving grade-school students, practicing and beginning teachers, and students enrolled in teacher education programs.

Distributed teacher education courses can assist learners in successfully transferring knowledge and skills from texts to real classrooms with real students, real challenges, and meaningful experiences. This approach can serve as a means for successfully introducing large numbers of disenfranchised teachers to opportunities for pursuing studies in teacher education. It can also function as a framework for addressing important questions about how to promote the application of educational networks for continued classroom instruction and lifelong learning beyond the conclusion of teacher education courses.

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Multimedia teaching at a distance: Emerging issues of computer-supported cooperative work in education and training

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Introduction

In many parts of the world there is increasing emphasis on school-based teacher education. Similarly there is an emphasis on children achieving their maximum potential. However it is difficult to locate sufficient expertise and resources in each school. One answer could be multimedia teaching from a distance, a form of computer-supported cooperative group work (CSCW) tailored to the needs of education and training.

At Exeter University School of Education we are using International Computer's Limited Desktop Conferencing systems (DTC) linked with British Telecom's Integrated Services Digital Network (ISDN2) phone lines to develop case studies which utilise the strengths of this medium for education and training. The systems are set up in three locations: the University and two schools. We are using them to enhance teaching and learning between university staff, student teachers, school pupils and school teachers. The current project developed several case studies. They are described in more detail in Davis (in press) and Wright *et al.* (1993). Video material has been edited to provide a richer view of the computer supported collaborative group work that occurred.

Issues relating to CSCW

The use of multimedia communication can permit participants to glimpse new forms of education and training, where learners can collaborate with their teachers in a way which has been rare, even when sitting side by side. It is almost as if the voice link plus the window of the computer screen permit both to feel as if they have ownership and control of the work being produced. I will use the following headings to discuss the emerging issues: timing, navigation and control, information and cooperation.

Timing

The synchronization of DTC requires care. The thread of communication is disrupted by delays over 10 seconds when participants wait for a response. Users seated at a workstation expect it to run at its normal speed even though communications are involved. Indeed, the computer screen was expected to synchronise with the immediate voice signal received and transmitted by the telephone. Tutors responded by making the pupils machine the host or 'chair' and by attempting to predict the outcome of their actions to speed the interaction. Despite this, more experienced users noted that the lag of the computer screen made the sessions less interesting, although they remained useful.

The disruptive effect of the delay was reduced using a more detailed lesson plan than is common for tutoring. This benefited the student teachers, who became more aware of the phases of a lesson and the participation that they should expect from pupils. However, the delays mean that the lesson took much longer than a face-to-face session.

At the other end of the time scale, scheduling the DTC sessions has required considerable care. Four systems were used across three institutions with several groups participating in each location. Each institution has its own timetable. In the pilot phase much of the work was done outside the normal timetables of all three institutions. Later it became part of the school timetables, but this disadvantaged the student teachers. Like many forms of IT, DTC requires flexibility of time and increased autonomy of pupils (Cory, 1991). In-service training, on the other hand, has benefited from the flexibility. Staff cover for forty-minute sessions is relatively easy compared to absence for courses away from the school premises.

Navigation and control

DTC requires several programs to run concurrently on both computer systems which are linked by the ISDN2 telephone lines. Users therefore develop a complex mental model of the technology underlying DTC and on several occasions we have noted that such models were incomplete or faulty. Even I have been surprised to find after a DTC link has been disconnected that I do not have the pupil's file that had been shown in the incoming screen. Intellectually I am aware that it is on the distant computer, but the immediacy and my manipulation of it make that hard to believe. Navigation has been assisted by standardising the desk top arrangement across institutions while colouring each uniquely.

DTC can be run in a mode in which the 'chair' has control and the 'participant' has to request to change items. The software even made the 'chair' confirm a new choice of pen colour. This is inconsistent with the required learning style, which should enhance the autonomy necessary for teaching at a distance. Also, as noted above, tutors tend to put pupils in the 'chair' so that they can show work they had developed on their computer with increased speed of computer response. The need to request permission is also inappropriate for consultancy.

Information

The view of participants' faces is assumed by many to be the most important source of information between teachers and pupils. Although the pupils were curious, the lack of this video has not been disruptive because the focus of our tasks has been on the screen and keyboard. The task is therefore a key to reducing the need for video. However, participants do lack cues which indicate what others are about to do next. In face-to-face situations such information is often provided by the direction of a glance, the movement of a hand or a hesitation. This lack of information was noted in a tutor's diary after he had viewed video tapes of both ends of the DTC link:

"Although Vi was doing most of the talking, Di was doing the deeper thinking. In fact Vi was quite often relaying, unbeknown to me, Di's answers. Assessment of group work would be very difficult through DTC. Di was quite often doing a significant amount of pointing at the screen, which of course I am unaware of. I think I should ask them to share the light pen and mouse more equally in future, otherwise Di will get very bored as Vi takes over. The pupils have become confident enough with the technology to instruct me in the use of the flipchart when I am not quick enough (Vi told me that I would have to open a fresh page as I had the chair)." (10/11/92, BW)

The ICL phones with extra buttons, mike and loudspeaker work well permitting groups to participate at each workstation. Occasionally listeners misinterpreted what they heard, for example, 'Eh' for 'OK' which caused some confusion. This is because the direction of speech is the screen or other people rather than the phone's microphone. Tutors also noted that their teaching manner was adversely affected by having to speak into the microphone:

"I was very surprised to see the effect of (my) using the hand set, rather than the telephone speaker, at both ends. It affected my posture (more relaxed), tone of voice (quieter), teaching style (more supportive and collaborative), and teacher-student relationship (more positive and informal)." (17/11/92, BW)

At the other end of the scale there are times where the teacher suffers from an information overload which is similar to an over-busy classroom, but also different. The tutor has several different channels of information to attend to: the local workstation running at least two different applications; the incoming window from the distant workstation; the telephone hand set's buttons and lights; the audio phone line which may have a number of voices on it; and the non computer based materials. Using this information the teacher will be building a mental model of the learners and using that to guide actions. Where significant dissonance builds up, most tutors suffer an information overload. We have tried to avoid this by structuring the sessions more closely than would be normal to our teaching style and to continually seek confirmation from the distant participants that their workstation is behaving as expected. In contrast, younger participants rarely find this a problem.

The anonymity of computer conferencing has been shown to produce more extreme behaviour (Spears, Lea and Lee, 1990). We have found little evidence of this possibly because the communication is almost immediate and the voice connection decreases anonymity. We have also used the effect to simulate events. The 'Desert

Storm' case study described by Wright et al (1993) provided realism such that a few pupils found it hard not to believe that they communicated with Moscow.

Cooperation

Group work is one aspect which employers request of education. When bringing a group together the first activity is frequently designed to 'break the ice' so that members will be able to establish working relationships. It was therefore felt that such an activity would also be important in DTC. It was merged with an introduction to the DTC software so that the range of tools available (flipchart, software sharing and file transfer) were introduced in a meaningful and enjoyable way. The 'ice breaker' activity was based on "Who am I?". Clues were provided in a variety of media (jumbled text, pictures and sounds) to objects or people relevant to the pupils' subject. Participants at either end of DTC worked in friendly competition and through this a working relationship with each other and the software developed.

Individual difference in using multimedia communications were indicated for gender. Girls seemed more ready to communicate than boys. They were also more likely to act upon a suggestion from others in their group and from distant groups. Littleton, Light, Messer and Joiner (1992) suggest that the task and the 'audience' have a larger effect than gender on computer-based work. In the case of DTC the ability to communicate is also a factor. One unsuccessful case has been in teaching French to low ability students whose poor French meant that they were too shy to participate effectively.

One teaching method currently undervalued is of successive refinement in which experts in different domains share their knowledge within the process of developing an artifact. An example between computer novices who are subject experts with their opposing partner (computer experts who are subject novices) has been described for spreadsheets by Nardi and Miller (1990). Several of our case studies reflect this process to a greater or lesser extent. The most extreme case is where pupils 'taught' Autosketch to a student teacher with expert knowledge of Design and Technology. The student teacher then helped the pupils refine their application of Autosketch using expert knowledge of the design process. The student teacher also learned about the way in which the pupils understood both the software and the design process at various stages. The teaching process continued to refine the artifact while also successively refining both the pupils' and the student teacher's skill and knowledge.

Conclusions

Multimedia computer conferencing can work in education and training. It can extend the curriculum and the resources and can be a vehicle for in-service teacher education in addition to providing insights into the process of teaching and learning for student teachers and research. The cost benefit analysis has yet to be done, but we are confident that a package of applications together will justify the expense. The issues discussed will not prevent DTC from becoming a valuable tool for education and training, especially in newer more autonomous modes for learning. This is certainly a fascinating area of research and development.

Acknowledgements

This project was supported by the UK Department of Employment, Exeter University, British Telecom PLC, ICL, Microtek , Aldus, Autodesk, and the staff and pupils in St. Thomas High School, Exeter and Knowles Hill School, Newtown Abbott.

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Application of telecommunications to clinical teaching experiences

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It is commonplace to find requirements for various kinds of field experiences in teacher preparation programs. Students complete between 30 and 150 hours of clinical experiences before being admitted to teacher training and 50 to 100 hours before entering student teaching. The time devoted to student teaching ranges from 7 to 19 weeks (Blanton & Moorman, 1985).

Research On Clinical Teaching Experiences

Research exploring the effects of clinical teaching experiences has provided weak results. For example, trainees who observe in classrooms or participate in classroom instruction do not perform better than their control peers in future courses (Hedberg, 1969; Ingle & Robinson, 1965; Ingle & Zaret, 1968). Likewise, there is little evidence that early experiences lead to better student teaching performance (Scherer, 1979). Similarly, the literature offers little indication that student teaching experiences facilitate induction into the real world of teaching. According to Peck and Tucker (1983), by the end of student teaching, there is an almost universal decrease in attitude toward student teaching, as compared to the starting position of trainees.

There are a number of factors contributing to the problems related to clinical teaching experiences The most significant influence appears to be context. As an illustration, Richardson-Koehler (1988) reported that student teachers reject the content of their university courses after as little as two weeks in the clinical setting. Trainees are usually confronted with conservative practices, structured and prepackaged curriculum, and deskilled teachers who are often more mechanical than deliberative (Goodman, 1983). Poor communication is another factor. There is often conflict among members of the student teaching triad. Cooperating teachers often think there is one set of goals, while student teachers and university supervisors have another agenda (Campbell & Williamson, 1983; Martin & Wood, 1984). Members of the triad also tend to blame each other for problems. From the beginning to the end of student teaching, members become more negative toward each other and dissatisfaction with the role of the university supervisor becomes more prevalent (Griffin, Barnes, Hughes, O'Neal, Defino, Edwards, & Hukill, 1983).

The supervisory process is also a major factor. It appears that the process of student teaching supervision may prohibit the construction of knowledge structures required for successful classroom teaching. The research reveals that most conferences between interns and supervisors focus on factual descriptions of events, management, and procedural issues (Zeichner, Liston, Mahlios, & Gomez, 1988). Surprisingly, Zeichner and Liston (1985) reported that less than one percent of supervisory discourse was devoted to the critical analysis of teaching. Rarely was the focus on conditional knowledge related to why particular decisions were made about teaching. In conferences with the cooperating teacher, the teacher talks over 70 percent of the time (O'Neal & Edwards, 1983; Richardson-Koehler, 1988). Very little of this time is devoted to critical analysis of teaching.

Group seminars for interns focus on concrete events (Zeichner & Tabachnick, 1982) or mastery of procedures and management (Lanier & Little, 1986). Being narrow in focus and targeted on immediate needs, critical thought and reflection are seldom observed during group seminars (Liggett, Fulwiler, Clark, & Hood, 1988).

In summary, research on the effects of clinical teaching experiences reveal a number of problems. First, university supervisors, cooperating teachers, and interns have problems communicating and understanding the expectations of clinical experiences. Second, the supervisory process does not seem to facilitate interns' applications of formal concepts to the real world of teaching or to construct meaning from the everyday practice of teaching. Third, interns seem to reject formal knowledge acquired at the university at the beginning of their clinical experience. This problem may be linked to the lack of communication with others as they try to interpret and reflect on classroom events and construct knowledge structures. What seems to be sorely needed then, are interventions based on new theory and tools.

Application of Socio-Historical Theory and Telecommunications To The Clinical Preparation Of Teachers

We propose that socio-historical theory and telecommunications have a great deal of potential for creating solutions to many of the problems confronting the clinical preparation of teachers. Socio-historical theory is associated with the ideas of the Soviet school of psychology. Important figures of this school are L. S. Vygotsky, A. R. Luria, and A. N. Leontiev.

A fundamental tenet of socio-historical theory is that human activity is mediated through tools and is socially organized (Lektorsky, 1984). He described the unique character of human activity as:

> "...joint or collective activity in which each individual enters into certain relations with other persons; as mediated activity in which man places between himself and an external, naturally emerging object other man-made objects functioning as instruments or implements of activity; and finally as historically developing activity carrying in itself its own history." (p. 136-137)

In other words, tools are created and modified by human beings as a way of connecting to the real world and regulating interactions with the world, themselves, and each other. Each individual attains consciousness by engaging in tool-mediated activity which unites the mind with the real world of objects (Ilyenkov, 1977).

Wartofsky (1979) has offered the idea that tools are to cultural evolution as genes are to biological evolution. From his perspective, axes, hammers, pencils, books, microcomputers, telecommunication networks, and so on are examples of primary or instrumental tools. Secondary or psychological tools consist of tools such as language, ideas, scripts, and modes of action.

The concept of socially organized activity is important for the construction of consciousness. Consciousness is formed by the capacity of humans to engage in social forms of productive, constructive activity. According to Mehan (1981) "social structures and cognitive structures are composed and reside in the interactions between people." (p. 81)

Socio-historical theory also proposes that there are two kinds of concepts: scientific, and everyday (Vygotsky, 1978). These concepts have different origins and courses of acquisition. Scientific concepts are not limited to science. They also include knowledge systems. Scientific concepts are embedded in cultural systems and transmitted through schooling. In contrast, everyday concepts are acquired through participation and communication in experiences of social life. Everyday concepts begin with a grasp of concrete events and phenomena and develop by becoming increasingly more abstract as they move "upward" and are integrated into knowledge systems. Scientific concepts, on the other hand, are acquired through verbal exposition. They remain empty verbalisms until they move "downward" and make contact with concrete objects and everyday concepts. Most important, this comparative analysis provides a framework for thinking about moving formal knowledge to the level of meaningful practice and moving practical knowledge to the level of knowledge systems.

Next, the theory proposes that all higher psychological processes and concepts appear twice, or on two planes. First, they appear on the interpsychological plane in social processes, shared between and among people. Second, they appear on the intrapsychological plane as they are internalized by the individual (Vygotsky, 1978). Thus the meaning of objects, events, information, and other phenomena is constructed by social interaction and exists in the collective memory of social groups.

We predict that socio-historical theory and telecommunications are tools that can be used to solve the problems besetting the clinical preparation of teachers. In particular, we predict that cultural genes such as microcomputers and telecommunication networks will create a cultural expansion in the clinical supervision of teachers. Telecommunications is a tool which can mediate human activity by affording interactions and helping constitute social structures.

Applied to clinical teaching, telecommunications removes the boundaries of time and distance in communicating. Likewise, a telecommunications network can enable clinical teaching interns, cooperating teachers, and university supervisors to: (1) reflect on their learning, (2) use writing as a tool for both communication and thought, (3) create social contacts for critical analysis and reflective problems solving, (4) communicate about jointly addressed teaching problems, (5) mediate activity on learning to teach at distances in non-real time, (6) compare their experiences with others, and (7) to access information sources.

XCLINIC: A Telecommunications Network For Clinical Teaching

A telecommunications network was developed by the ASU-Public School Partnership, AT&T, Bell South, and Southern Bell. The venture is designed to utilize an Integrated Systems Digital Network, permitting full video, audio, and data transmission over telephone lines. Public schools in the partnership are equipped with a technology room containing 8 to 20 microcomputers and a multi-media terminal. Each multi-media terminal is a combination of video input and receiving devices such as cameras, monitors, and video tape recorders. In addition, computer peripherals such as scanners, projectors, and audiographs are available.

The participants in XCLINIC are cohorts of students in our teacher preparation program, their cooperating teachers, and university supervisors. All participants are trained in the use of e-mail and videoconferencing. At the present time, we have two classes of Introduction to Teaching students who participate in XCLINIC. These students communicate with each other and send fieldnotes to their professors. Next, two classes of junior-year students intern in classrooms and communicate on XCLINIC. Along with communicating among themselves, they keep diaries and logs and they e-mail them to their professors. Finally, a cohort of student teachers is placed in the schools. In addition to communicating on XCLINIC, these students engage in notes conferences via e-mail and attend seminars via videoconferencing. In addition to the above activities, the network is used for normal management and social discussion.

We are currently in the process of analyzing student fieldnotes, journals, diaries, e-mail activity, and video conferencing. In addition, we are collecting user data from students to determine the level of satisfaction with XCLINIC. The papers of Thompson and Blanton and Zimmerman and Blanton presented in these proceedings provide some of the results of this effort.

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Evaluation research on telecommunication applications in teacher education

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Learning to teach is learning in and about an ill-structured domain. Ideally, learning experiences for prospective teachers should focus on goal-oriented, contextualized activities and the situation-specific use of knowledge. The learning experiences should provide multiple perspectives for using knowledge to interpret classroom events and to solve problems. Unfortunately, traditional teacher preparation programs tend to provide "handed knowledge" to students in the form of reading textbooks, lectures, and discussions. The expectation is that this knowledge will emerge effortlessly as teaching skills during the clinical teaching experiences of internships and student teaching. In effect, traditional teacher preparation programs reduce the complexity of teaching and present synoptic views of teaching to their teacher trainees.

Theoretical Alternatives

There are many possible alternatives to the difficulties mentioned above. Two research-based theories seem to offer reasonable options, especially when combined with telecommunications. The first theoretical alternative is the concept of reflection. Many scholars have encouraged the concepts of reflection and reflective practice in the preparation of teachers (Schon, 1987; Richardson, 1990; Fenstermacher, 1988; Posner, 1989). Reflection enables us to consider the consequences of our actions in light of our past experiences and the ideas derived from our formal study of education. Together, these two activities increase and/or accelerate our learning in contextualized activities and settings.

The second theory that we think has the potential for creating solutions to many of the teacher education problems is the socio-historical theory (Vygotsky, 1978; Lektorsky, 1984). This theory proposes that abstract concepts such as teaching are acquired through verbalization. The meaning we align with or give to our actions, the events around us, and the information we process is constructed by social interaction. A more complete description of socio-historical theory is presented in a paper by Blanton and Thompson in these proceedings.

We believe that constructing activities in clinical, field based settings based on socio-historical theory and reflective practice offers an exciting possibility for teacher education, particularly when we link those activities to microcomputers and telecommunication networks. Telecommunications becomes the tool which activates reflection and verbalization.

Description of the Network

During the fall 1991 semester, Appalachian State University, AT&T, Bell South, Southern Bell, and a teacher education-public school consortium/partnership began a cooperative research venture to explore applications of telecommunications in teacher education. The venture is designed to utilize an Integrated Systems Digital Network (ISDN), a state-of-the-art technology which permits full video, audio, and data transmission over normal copper telephone lines in order to enhance teacher education and public school education in western North Carolina.

In preparation for this project, an ISDN switch was installed in the central office of the local telephone service agency along with an ethernet in the College of Education. A local network was established among the university site and three public school sites. Each site was equipped with a technology room, a multimedia terminal, and a computer lab with 8-20 computers. Each multimedia terminal is a combination of video input and receiving devices (cameras, monitors, and video tape recorders), microphones, computers and computer peripherals (scanners, projectors, printers). Teachers were trained in all three sites and university faculty were trained at the College of Education site in the use of all network resources.

With the establishment of the network, university and public school faculty designed a series of activities intended to address (a) the theoretical models we are using as our base, (b) the problems normally associated with supervision at clinical sites in rural areas, and (c) the integrated, daily use of telecommunication tools. The four current activities are:

1. Daily e-mail journals sent to supervisors.
Journals are structured to focus on reflection and transfer of learning. Supervisors communicate daily with interns and/or public school teachers.
2. Electronic notes conferencing which allows extended time and space for student or teacher/supervisor topics of interest or need.
3. Video conferencing between student interns/teachers and university supervisors and also between student interns in other schools.
4. Performance assessment options developed and communicated by student interns via electronic conferencing.

Because of these network activities, the project has seen many changes/improvements in what and how our novice teachers learn during their clinical experience. Due to the provisions of tools, time, and specific formats that lead interns through the reflection and verbalization processes, supervisors and cooperating teachers are able to respond to intern behavior and concerns as they occur and provide immediate and long-term follow-up. Teachers, interns, and supervisors conduct situation/topic analysis in contextualized settings at or very close to the time of occurrence and work on reflection, generalization, and transfer. An entire area of performance assessment for student internship evaluation has been instituted by interns constructing portfolios. The journals and field notes are proving to be rich sources of cases for use in the classroom curriculum on campus. And finally, the College of Education uses the data from the analyses to conduct formative evaluations of various components in the teacher education program.

Evaluation Research Design

Formative and summative evaluation research studies have been designed to evaluate the project's effectiveness. Data are being collected and analyzed on all four project activities. Our "data" comes from our designed telecommunications activities and consists of e-mail journal entries and field notes, the dialogue transcripts from notes conferencing, the transcripts and video records from the video conferencing, and interns' writings in their portfolios. Since the data and analyses will be qualitative, our research and evaluation methodology became qualitative.

There are many types of qualitative research and many different ways of handling qualitative data. The desired result of our analyses of the data is some type of higher level synthesis. While we initially work in the analysis process which consists of breaking information into smaller parts, the final goal is the emergence of a larger, consolidated picture.

An example of this process was a qualitative analysis of sequential e-mail entries for classroom management "codes" (the analysis component). We wanted to (a) determine the extent our interns were discussing classroom management, (b) see if their perceptions, and hence discussions, changed over the placement period, and (c) evaluate our program's curriculum in classroom management. First, a content analysis was conducted to determine both the number of entry phrases concerning classroom management and how the terms used differed across experience levels and grade levels. Second, we conducted a discourse analysis (van Dijk, 1985) or conversation analysis to answer questions such as "how is discourse on classroom management constrained by experience and/or by prior knowledge?" or "how is discussion used to get needed information. Third, an event structure analysis (Bakeman and Gottman, 1986) was conducted to discover regularities in the sequence of events and any possible structures or rules that were governing the sequence of interactions.

The synthesis of our data led us to the discovery that our interns follow a pattern of "awareness" concerning classroom management. First, they exhibit almost complete dismay about their lack of experience and training in that area now that they see the problems, and classroom management issues were discussed much more frequently than any other issue during the first 5-8 days of the internship. However, except for isolated incidents or a particular "problem", very few discussions on classroom management issues took place toward the end of the internship. Second, they look to others for immediate, simplistic help rather than to their prior, learned knowledge. Third, they begin to see classroom management as a process of options, until finally, they begin using a decision-making model, choosing from their options on an individualized basis to systematically solve their own problems.

As we analyzed the data, this larger picture of students learning about classroom management emerged. When we saw the total picture and discussed it, we realized several parts of our curriculum needed to change. We now plan to enlarge the component for classroom management and include several strategies for individual, small group, and large group management. The strategies will be in a resource packet that student interns use, not memorize. We will use many case studies to introduce students to the area and contextualize their learning prior to the field placement, employ decision-making models within student discussion groups in classes and in the field, and finally, continue to use telecommunications in their clinical settings.

A second example of our research design is the analysis of the notes conferencing activity. One series of telecommunications concerned teachers' uses and techniques of questioning. By conducting discourse analyses and event structure analyses, we found varying levels of knowledge, expertise, and therefore, discussion on this topic. Our socio-political model provided a Vygotsky paraphrase..."learning is first a social activity before it is a cognitive activity" to guide a program adaptation. The varying levels of discussion, if structured appropriately, could produce learning rather than just reflect learning. Next semester there is a plan to adapt the notes conferencing so that interns, faculty and public school teachers take part in a structured series of enrichment (for those with information and examples to share) and corrective (for those needing additional support or information) discussions.

Our research design includes other qualitative and quantitative methods in addition to the examples' uses of content analysis, discourse analysis, and event structure analysis. Other analyses used or in the planning stages to be used are:

1. Ethnographic content analysis (Altheide, 1987) to document and verify the theoretical relationships in the project;
2. Evaluation research analyses (Suchman, 1967) to determine whether any activity by itself or in relationship with one or more other activities has the results it is meant to have; and
3. Educational ethnography (Goetz and LeCompte, 1984) to obtain descriptive data about the contexts, activities, and beliefs of interns in educational settings.

Summary

As the above examples illustrate, by using two theoretical models for a guiding activities and program adaptations in combination with telecommunications, a College of Education can provide more goal-oriented, contextualized learning and maintain closer contact with students in their early field-based learning experiences than traditional teacher education programs. Students combine their experiences with immediate reflection and discussion to learn about the complex task of teaching. We continue to look for good and poor examples of generalization and transfer within our curriculum, while being guided by the idea that small changes in practice are usually accompanied by larger changes in thinking.

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Invitations to shared thinking: Using telecommunications in teacher education programs

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"The performance of experts, though not necessarily perfect, provides a place to start when we instruct novices" (Berliner, 1986). With this thought in mind, future teachers are placed in classroom settings for closely guided observations and interactions with students as an integral part of their teacher preparation program. Through these experiences, novice teachers are expected to develop critical thinking skills, routines, and professional schemata. How these beginning teachers think and the significance of the conceptual development phase of teacher education are important issues (Joyce & Showers, 1980). Teaching is complex and the nurturing of this development is essential in gaining knowledge about goals, decisions, actions, and outcomes. As Clark and Lampert (1986) advocated, "research can pose questions, but teachers and teacher educators must provide the answers."

To assist novice teachers in generating questions and reflecting on the experiences of classroom life, journals have traditionally been used (Shon, 1983, 1987). An important feature of journal writing is feedback that prompts and directs further reflection in the thinking process. Problems with these journals have been:

1) lack of feeling of support in the field and feelings of isolation from peers,
2) need for collaboration on teaching methods, and
3) lack of direction from cooperating instructors.

Blanton (1992) noted that traditional dialogue journals may restrict student growth. First, students submit formulated positions and may not receive prompt feedback from supervisors. Second, the established teacher/student relationship may inhibit students from revealing their opinions and positions accurately because students are constantly attempting to "say the right thing" and "please the teacher."

To facilitate journal writing and to explore the problems stated above, the proposed study was created. In the past few years educators and their students have been exchanging ideas across computer networks through discussion forums (Pierce, Glass, & Byers, 1991). Authors have shown many successes with these networks and also warn us of the possible detractors from this success. The clear message is to integrate technology, not inject it, and to keep in place what we already know about teacher training and add value with networks (Marker & Ehman, 1989). In this study, the concept of communication was extended and incorporated into the clinical teaching experience of a group of sophomore and junior interns. An electronic mail (e-mail) network was used for interactions among tutors in the classroom and supervising professors. Two main outcomes were desired for this study. First, e-mail would allow quick response time and more frequent exchanges with tutors in the field, thus aiding their planning, framing of events, and reflections on the teaching process. With this additional interaction it was believed that feelings of support would improve. Second, e-mail journal entries would allow more expressive, unencumbered feelings (Dede, 1990). Thus, researchers would explore different physical settings for tutors and amounts of supervision.

Procedures

Participants and Setting

The future teachers referred to as tutors were "teaching fellows" at Appalachian State University. This group of students was on full scholarship for high academic achievement and their commitment to the field of education. The 18 students were sophomores and juniors who had completed between 40 and 115 college level hours. They had all completed at least one education course and 3 students had completed three education courses. Half of the tutors reported having previous computer training. These teaching fellows were placed in public schools for one year to assist with academically at-risk students. Two groups of tutors were examined using the e-mail system. The first group of tutors were placed in a traditional tutor role of working directly with the classroom teacher and children designated as at-risk (Group 1). The second group worked with students who were tested and labeled at-risk by qualifying for remedial reading services (Group 2). These tutors worked directly with the Chapter 1 reading teachers in the school and were given a very structured outline of what and how to teach these students. In this structured environment there was less control over the setting, materials, and methods. Lesson plans were written by experienced teachers and the tutor's role was to follow the plans. In contrast, the tutors placed with classroom teachers were given subjects or workbooks, but no specific plans on how to teach.

Evaluation

Participants were asked to write e-mail entries at least once a week. Suggested guidelines for journal writing were stated as:

1) a heading (date and time of experience),
2) observations of episode,
3) elaboration of one or two significant events (including framing the event and reflecting on the event), and
4) general reflections (comments about planning, teaching and yourself).

These entries were responded to on a daily basis by the supervising faculty member. Careful records of all e-mail transactions were kept for later analysis. This analysis was made in several ways. First, a survey was distributed to all participants to look at attitudes of using e-mail, advantages and disadvantages, and areas where feelings of effectiveness and ineffectiveness were found. Second, entries were coded and analyzed for individual similarities and differences regarding perceptions, opinions, and attitudes related to teaching issues by employing the principles of the comparative method. Third, journal entries were analyzed for comparisons and contrasts between tutoring groups. These comparisons included:

1) a case analysis to examine the most frequently reported events of concern,
2) evaluation of experiences (structured versus less structured), and
3) differences between the two groups of observations and reflections.

Results

Analysis of Survey

As a group, all of the tutors responded to a survey which reviewed the effectiveness of the e-mail journal writing system. Tutors were asked to rate items on a continuum from least effective to most effective. The three items which tutors rated as most effective were:

1) receiving moral support,
2) developing a broader perspective on teaching, and
3) understanding problems in teaching.

The other items were rated similarly as being effective.

These included:

1) fulfilling course requirements,
2) reflecting on philosophy of education,
3) sharing teaching techniques,
4) improving classroom techniques, and
5) reflecting on teaching.

Differences were found between the groups of tutors. Group 1 responded that e-mail was most effective developing a broader perspective on teaching and fulfilling requirements. They found it least effective for improving classroom techniques. The responses from Group 2 were similar to the total tutor responses.

The comfort level of tutors was also questioned pertaining to computers and e-mail at both the beginning and the end of the semester. The level of both groups raised from an average of 4 to 5 on a 7- point comfort range. Students commented that e-mail helped them focus on the important things that they had learned, it made responding quick and easy, allowed reflection, became a great personal tool, and helped closely monitor the environment. On the other hand, responses included criticisms of the system such as: inconvenience, lack of typing skills, inaccessible computers, computer screens difficult to edit, time consuming use of computers, and duplication of journal entries. Positive comments and a high comfort level with e-mail were positively related. Half of the tutors stated that e-mail should be a choice, not a requirement.

Analysis of Journal Entries

There were 108 entries to analyze from the 18 tutors. The most commonly reported events of concern for all tutors were categorized into three areas:

1) academics,
2) behavior, and
3) teaching skills.

Seven entries expressed concern for students with regard to specific problems with reading, math, and homework skills. Twenty-four entries stated that students were having problems with behavior. The most frequently reported concern was with motivation followed by off-task behaviors. The concern of needing additional teaching methods for their students was presented eleven times. These desires for additional training included areas of reading, motivation, lack of progress, frustration, and off-task behavior.

Upon reviewing the groups of tutors, there were some definite differences in what was reported by these groups. Group 2 was much more predictable in what was going to be stated in the journal entry. Descriptions of academics and procedures were more dominate. Most entries stated the times they had tutored, who they worked with and specific reading skills, such as word attack skills that they had dealt with. They all followed the format of oral reading, questioning, word attack activities, and listening to reading by the tutor. Group 1 listed more broad subject areas in which they had tutored, such as history, algebra, and reading. Characteristics of students were equally reported by both groups, as was reporting about teachers and teaching styles. Differences were also seen in the areas of behavior and progress. Group 2 reported academic progress much more frequently than did Group 1, whereas, Group 1 reported behavior concerns at a higher rate than did Group 2. As far as progress made, Group 2 reported more in behavior and academics and Group 1 made more future predictions such as, "I will continue to have hope and a positive attitude" and "I am gaining more patience." More tutors in Group 1 reported that they graded papers, played with computers, organized flash cards and had less direct interaction with students than Group 2. One of the tutors in Group 1 expressed concern with the level of communication with their supervising teacher. Group 2 never expressed this concern.

There were five entries which cited either education classes or articles on education in them. Two referred to information on cooperative learning and one dealt with homework, all discussed in education classes. Two journal entries referred to articles on reading miscues and teaching strategies.

Discussion and Implications

Results showed mixed reactions of tutor opinions on effectiveness of using e-mail for reflecting on teaching but overall they gave it high marks as a way to effectively develop a broader perspective on teaching. It is not surprising that comfort level of using computers and e-mail was positively correlated with positive feelings toward using e-mail. For at least half of these participants, this was the first time that they had used computers. With added time on computers, some of these negative feelings may be reversed.

Two major consequences resulted from this research. First, differences were found in placement for tutors. The journal entries were very different in content from one setting to the other. This is very useful information for placing students in classrooms to optimize the tutoring experience. If the goal of the tutoring situation was to deal with behavior problems, the unstructured setting would be preferable. If academics was the goal, then participants should be placed in the very structured setting. Two facts should be noted here that pertain to these differences. Group 2 worked with second grade students while Group 1 worked with elementary and middle school aged students. The at-risk label given students worked with by tutors in Group 1 may have been chosen for behavior problems more than academics, whereas, we know that the second grade students were chosen on the basis of their academic skills.

Second, there were not many references to a variety of teaching procedures in either group's journals. Does this reflect on the effectiveness of the introduction to teaching course or is it further proof of the difficulties of correlating coursework to teaching? Additional training will be needed to answer tutors' concerns on reading, motivation, lack of progress, and off-task behaviors. Future education courses need to be reevaluated to supply this information. We as teacher educators need to make sure our students experience all aspects of teaching while they are novice teachers.

Implications for future research in teacher education and network technology include answering the questions posed above and looking into new areas such as: varied formats for journal entries, journal entries versus field notes, formative entries in comparison to summative entries, and varied feedback and its effects on e-mail use. The field of network technology is just beginning to explore the possibilities of this tool in education. This project was a first step in employing telecommunications to engage preservice teachers in conversing about and reflecting on teaching.

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The Appalachian Distance Learning Project: A national demonstration project in collaborative education reform

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The Appalachian Distance Learning Project (ADLP) is a collaborative effort between Ohio Bell/ Ameritech, GTE North, The Public Utilities Commission of Ohio (PUCO), Athens City School District, Dawson-Bryant Local School District, Ironton City School District, and the Ohio University's College of Education. This collaboration was established to bring about education reform. Through the use of fiber optics and two-way full motion video technology, preservice and inservice educators, professors, technicians, and administrators have the opportunity to provide third grade students at three elementary schools in Southeastern Ohio a multi-interactive distance learning environment. This environment allows all parties concerned to improve their pedagogical skills, and to use technology as an enhancement tool within existing curricula.

In the ADLP, technology underpins the curriculum through collaboration, cooperation, and communication in an environment where videodiscs, computers, and classrooms linked through fiber optic networks are commonplace. A graphic representation of this project is four C's (curriculum, collaboration, cooperation, and communication) supported by a T (technology).

The First C—Curriculum

The traditional curriculum, which consists of a course of study with a list of facts to be memorized with the teacher as the chief information giver, does not instill a need to utilize current technologies to assist in data collection, and places the learner in a passive role. This approach will do little to force educational reform, even when transported to a distance learning environment. The ADLP mandates the reconceptualization of current views of curriculum—content and delivery. The students will interact with one another over the fiber optic lines in small groups of five or six. One cannot simply transport the current thinking on curriculum into this type of environment. In the ADLP classrooms the learners play an active role due to their constant interaction with the technologies available. This shift in the role of the learner will create a need to change teaching methods. This project proposes the following for curriculum:

1) The teacher is regarded as a facilitator.
   The student takes on greater responsibility for learning. Knowledge is constructed through common, shared experiences between the learners.
2) Hands-on/minds-on, interactive, grade level appropriate lessons will be designed.
   This environment encourages student centered exploration first, where the student engages in process skills to manipulate materials to come to an understanding of a concept. After student exploration, the teacher engages in questions/ answers, or discussion

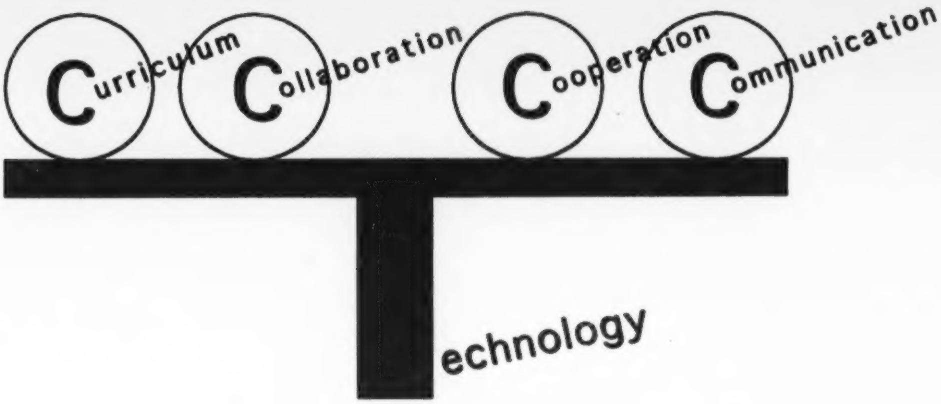

Figure 1. The "Four-C" Project Logo

with the students, so that together the concept can be invented. A student centered expansion activity is planned to reinforce the concept learned.

3) Assessment methods for evaluating student performance which are consistent with the goals of the ADLP have been created.
The states of California and Texas are piloting assessment programs which incorporate a hands-on, pictorial, and reflective component. The state of Vermont, through portfolio assessment, is encouraging assessment which requires the students to engage in more critical thinking processes like analysis and synthesis of information. Teachers involved in projects designed to enhance the quality of teaching, particularly in science and mathematics such as the Lead Teacher Project from Ohio University in Athens, have found that student achievement in activity based classrooms showed marked improvement when assessment was designed to include a hands-on portion, a pictorial portion, and a set of questions which caused the student to apply the concept taught. In the distance learning environment, a multi-faceted approach to assessment such as this will give a more accurate picture of the progress at hand.
4) As the teachers become more adept at creating lessons in a distance learning environment, eventually their preparation will expand to include approaches for integrating content areas.

Approaching curriculum in this manner brings about several other changes in the usual way "business" is conducted. The active learner can be expected to do several tasks in this type of environment to facilitate learning. Some of these include things such as:

1) Concept Mapping
In the Appalachian Distance Learning Project, where learners at the various sites come from culturally diverse groups, concept maps become tools for creating meanings between these students. A concept like "strip mining" at one school site may connote "degradation" and "destruction" of the land. At another site the students see these words as "jobs" or "economic growth." Concept mapping helps the students realize that the word itself does not create the concept, it is simply a label for the concept.

2) Group Learning
In the distance learning environment, students at different sites work together to create concepts, share experimental findings, and engage in discussions of activities performed. Assessment can be based on the progress of the entire group. This cooperative group learning promotes positive interdependence, how well they work together is one criteria for receiving a favorable grade. As the students continue to share information and learn from one another, the cultural barriers which exist between the different sites based on ethnic group, sex, or handicap soon begin to disappear.

3) Diary
The distance learning setting enhances the value of concepts learned when the students are asked to reflect on how the concept learned effects them personally. Asking the students to keep a diary of their reflections helps create links between subject content and personal growth — something rare in a traditional setting. Using the technology available in the class-

room, computers networked between school sites, the students share their reflections with one another and use concepts developed as points of further discussion or inquiry.

The traditional role of the teacher is expanded in the ADLP. A teacher in the distance learning classroom has many roles to fill. Not only does the teacher need to understand how to use the technologies available, and to plan appropriate, activity based lessons for this type of environment, but also needs to provide inservice education to prepare other teachers to be successful in this environment. They need to develop networks between teachers within their building and at other sites to share materials and equipment. Preparing programs to gain community support for an activity based, interactive, technology driven classroom also becomes part of their responsibility.

The Second C—Collaboration

As noted previously, the Applachain Distance Learning Project promotes increased collaborative efforts between many members of the educational arena. The students involved in this project may become the scientists, engineers, and mathematicians of tomorrow. They will be shaping the world in the twenty-first century. The curricular changes brought about by this collaborative effort will shape the kind of culture we see tomorrow. Knowledge and attitudes are affected by this collaborative effort.

The ADLP allows for student initiated research. In a collaboration the students at the various sites can focus on a problem. As the students at the three sites collaborate in cooperative teams to solve problems, the teacher remains a facilitator. Students concentrate their efforts on sharing local resources to help solve the problem. Groups from the three sites, which quickly solved the initial problem, and are encouraged to pursue more advanced problems.

In the ADLP while the role of the teacher is one of facilitator, the amount of work to keep all of the interactive groups flowing smoothly has more than tripled the traditional tasks of the teacher. Parents can become part of this collaboration by volunteering to work in the classroom as an aide. Teachers can facilitate this collaboration by providing training sessions to prepare the volunteers. The parents can assist by: providing an extra pair of hands during activities; preparing materials for each of the groups; helping students having difficulties to manipulate the materials to safely and successfully complete the activity; organizing clean-up, and supervising the return of materials; and participating in field trips (Pearlman & Pericak-Spector, 1992).

Practicing professionals can play an important collaborative role in a distance learning environment. Inviting professionals into the classroom adds a new point of view to a concept, is a way of making the concept more relevant with first-hand experience, and serves as a source for career information.

The Third C—Cooperation

Cooperation is a key component in the Appalachian Distance Learning Project. As educational reform continues teachers are beginning to see the importance of creating activity-based, inquiry oriented lessons. The interactive nature of the distance learning environment necessitates the creation of activity-based lessons to promote greater exchange between the sites. From pilot tests of lessons designed for the ADLP, it has been found that although the students are coming from classrooms in which science activities have exposed them to science process skills, they lack the cooperative skills necessary to achieve group consensus on particular concepts. Cooperative learning skills are incorporated into this project to enhance the interactive experience, decrease competitiveness, and to promote a collaborative view of all subject areas.

The Fourth C—Communication

Technology has changed the way people communicate with one another. Computers, fax machines, electronic mail, voice mail, and teleconferences have reduced the need to travels hundreds of miles to share information. Effective communication is not ignored in this project. Successful use of the technologies available make it imperative to create lessons which encourage the students to utilize as many of the existing forms of communication as possible. Communication is a key element in many important discoveries. The recent cold fusion debate illustrated the need for effective communication among the scientific community. Claims of cold fusion were found to be unsubstantiated when other scientists throughout the world were unable to duplicate this work after they were given information about the methods used.

When science is viewed as a private matter conducted by independent scientists throughout the world, sharing of information and solutions to problems like cancer and AIDS are slow to arrive. Private science perpetuates the myth of the scientist working alone in a room filled with smoking test tubes. This project creates the need for the learners to communicate with one another to create a science, mathematics, social studies, or any other subject area concept. As these learners come to realize that learning can be a cooperative undertaking, the traditional stereotypes often associated with professionals in various career areas will soon begin to crumble.

The interactive nature of this project is also designed to communicate the need for change to a more activity-based, inquiry-oriented classroom. Many teachers claim that this type of approach is not possible due to lack of materials and equipment. There are schools in which equipment needs are met, yet the materials sit unused. Communicating ways in which materials can be used to enhance learning is an important part of this project. This project is designed to incorporate as many of the existing technologies into the educational experience as possible, to evaluate their effectiveness in enhancing science achievement, and sharing the results with other educators through many different communication networks. Instructional videos, slide presentations, and journal articles are just a few ways in which this information can be shared.

The Base "T": Technology

"He that will not apply new remedies must expect new evils, for time is the greatest innovator."—Francis Bacon (1561-1626).

The effectiveness of technology in the classroom has been debated for years. Can computers really free teachers so that they will have the extra time to work one-to-one with that child who needs special attention to excel? Teachers have not been adequately prepared to teach their subject-matter and implement technology. Cost factors and the fear of using a machine to teach have also impeded its proliferation. The early efforts in designing computer systems that would allow teachers to share software and do so inexpensively worked to a limited degree. However, we are entering a new age of technology whereby teachers can design their own software without using programming languages. Computers currently control various delivery systems which can be used to deliver a multitude of media types for learners of diverse populations. Through the cooperative efforts of business and universities to work with our schools, and the cost of technology becoming more affordable, we have opened avenues and learning opportunities that were once unaffordable to some school districts.

The ADLP is establishing paradigm shifts that require innovative and creative approaches to teaching and the preparation of future teachers. Preservice education curricula are expected to provide preservice educators with skills which: allow them to become experts in pedagogy and their subject-matter; design syllabi to meet the needs of below average, average, and above average students; design syllabi and lesson plans geared toward special education students and culturally diverse student populations. The demand to enhance these skills for preservice educators is magnifying. As a shift in teacher perspectives and the preparation of preservice educators occurs, the ADLP puts technology in the hands of the third grade students. The interactive distance learning classroom is designed to develop process skills, enhance the student ability to think critically, solve problems, and make sound decisions concerning problems.

A technology based, activity oriented, interactive, distance learning environment requires the teachers to assume the role of facilitator of information, "subject matter specialists." The students share in the classroom management, by taking a more active role in making decisions for their learning. The technologies do not become simply means for recovering information, but actually reinforce the notion of education as a verb, one of "discovery rather than recovery." The technologies serve as a support for the curriculum. Collaboration, cooperation, and communication bring about successful experiences in an interactive distance learning classroom.

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Dale and Maggie's most excellent adventure: Designing a technology course to be delivered via interactive compressed video

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How We Arrived Here and What We Are Doing

The College of Education at the University of Wyoming has a working partnership with public schools throughout the state. The purpose of the partnership is to simultaneously restructure schools and teacher education. One of many benefits of the partnership is to be eligible for grants from U.S. West to develop and deliver courses over the University's interactive compressed video network. The grants are awarded to joint teams of partnership public school teachers and College of Education faculty. Dale Parker, a local high school social studies teacher, suggested that he and I write a grant proposal to design, develop, and deliver a technology course for teachers in the state. Our proposal was accepted, and we began work early this semester (Fall, 1992).

This project is a departure from my normal modus operandi in two major respects: I am developing and will eventually be teaching the course as part of a team rather than by myself, and the medium of delivery will be interactive compressed video rather than face-to-face instruction. Many of my ideas about teaming and about compressed video have changed through the process of designing this course. I have learned about the synergy of teamwork. I have also learned about myriad issues, both institutional and technical, that surround distance education. Attempting to teach a hands-on technology course when you're only connected to other sites by compressed video and audio has obvious obstacles. Some of the problems we face have turned out to be advantages in the long run. Certainly an awareness of the issues is essential for anyone embarking on a similar project.

Our course has some persistent and unique challenges because it is a technology course. Our goal is to teach teams of teachers throughout the state how to use technology to break down subject-area barriers. We plan to teach them how to use technology tools like personal computers, video cameras and CD ROMs to develop interdisciplinary units for their students. Further, we will expect teachers to think in terms of developing a prototype or model, so that their *students* can ultimately become developers and deliverers of interdisciplinary projects. We also hope to prepare teachers for and support them through the changes that come as a result of teaching in a technology-rich environment.

The purpose of this paper is to describe our progress so far in the following three areas:

1. fostering and supporting teachers' technology integration,
2. working effectively as team members, and
3. discovering the possibilities and limitations of our mode of delivery, interactive compressed video.

The first area, fostering and supporting teachers' technology integration, is essentially our course content. The second and third relate more to course development and delivery issues.

How to Foster and Support Classroom Technology Integration

The culture, spirit, and atmosphere of the classroom change when teachers and students use computer tools effectively in teaching and learning. The ability for users to access and process information, to allow modeling and creativity, and to free the imagination to enhance the learning process comes with these tools. These capabilities allow computer-using teachers to become co-explorers with their students rather than being merely dispensers of knowledge (Goodson, 1989). Our team wrestled with the question, "What kind of tools and skills do teachers need to fully exploit the power of technology?"

Criswell (1989) states that teachers need practical experience integrating computers into classrooms. He further recommends that training for teacher-education instructors should be developed that will permit them to appropriately model the use of computers in classrooms as an instructional tool. This practice would support the integration of computers into the learning process as a whole and provide a much-needed model for pre-service teachers. This is a philosophy with which our team is in complete agreement.

Our challenge, in this course then, is to model appropriate technology integration and to prepare teachers for new roles. Along with experiencing a good model, teachers also need the practical, hands-on instruction necessary to use technology in its most powerful way. After the initial learning and development, follow-up support is critical. Farley (1992) recommends post-training consultation and reinforcement of individuals and small groups of teachers until the novice develops into an experienced, effective user of technology. This is where a problem with the compressed video system worked to our advantage.

We were initially committed to teach our course during the spring semester, but the network was booked to capacity. Our network serves community colleges and state government entities as well as the university, and scheduling is a problem. As we wondered whether to offer our course during the summer or fall terms, we came up with what we think is a better alternative to either one. We will offer our course during *both* summer and fall terms. That is, teachers will begin their initial instruction and planning during the summer when they are likely to have more time to explore and learn to use new tools. They will work in teams to design and develop interdisciplinary units. Then during the fall, we will meet to provide support and reinforcement of their new skills and to allow teachers time to teach their own classes using their interdisciplinary units. Later we will meet again to discuss their teaching and technology experiences. We feel that by extending instruction and support over time, we will optimize the learning and integration of new skills.

In our proposal, we targeted secondary teachers as the audience for our course because we feel they are a group in need of breaking down subject-area barriers. We were encouraged to depart from this thinking by a colleague who teaches elementary methods courses. This colleague felt that elementary teachers could benefit from our objectives just as much as secondary teachers. We agreed that there is no real reason to limit our audience since each team of teachers will be developing and teaching their own units anyway. We also decided that teachers must enroll in our course with a partner-colleague who will co-develop and team-teach their units. Our plan is that two secondary teachers in two different subject-areas or two elementary teachers will combine forces to teach their units. They will then have a built-in mutual support system.

Teamwork

Jointly writing the grant proposal was the first step in this teamwork exercise. Actually, our proposal was written by one team member and then revised by the other. Hence, the proposal really wasn't a collaboration in the truest sense of the word. However, both of us were busy as the deadline neared, and we were both satisfied with the finished product. As soon as the proposal was accepted, we met to discuss the guidelines of the grant with the grant administrator. We agreed to make all decisions relative to the grant jointly. Our first joint decision was to choose another teacher to join our team, because Dale and I are both located in Laramie. One of the requirements of the grant is to develop the course over compressed video. We needed at least one team member at a remote site. Our administrator encouraged us to choose more than one teacher at more than one site, to be able to fully explore the compressed video capabilities during the course development process. We decided, however, that having more than three of us working as developers and instructors would be too cumbersome to be practical.

Our grant administrator called for applications from teachers in the state to join teams, and the response was good. We had many excellent teachers from which to choose, but we chose Jim Rogers, whose technology background is particularly strong. He is his school district's Technology Coordinator. We felt his expertise would be vital as we explored ways to deliver the course over the compressed video system. He travels about twenty miles from Green River to the compressed video site in Rock Springs, which is about 200 miles from the University. Philosophically, Jim has strong convictions about the place of technology in schools which closely match our own.

As soon as our team grew to three members, we began to feel the need to be more structured in our meetings. We also had to schedule the compressed video network early in the semester for our development meetings. The only time the three of us were free when the network was available turned out to be over the lunch hour one day a week. Having a weekly meeting has been a good development tool. It gives each of us time to reflect on issues and find answers to questions that come up each week.

Initially, we spent a lot of time experimenting with the cameras and equipment in order to understand the capabilities of the system. As the semester went on, we began to feel an urgency about writing our syllabus. We initially decided on having each of us teach one or two technology tools on successive meetings of the class. That way, teachers taking our course could learn about a variety of tools and then choose an appropriate combination to develop an interdisciplinary unit.

Then it occurred to us that we were teaching about technology in isolation, something all three of us were opposed to on philosophical grounds. If we truly believe that technology is a tool, then we needed to decide on our content and then use appropriate tools to help us deliver it. We needed to model the same approach we want our teachers to take. We decided to each plan and design an interactive interdisciplinary unit. We will demonstrate the unit, and then teach the techniques and skills necessary to develop a similar unit. It was during the excitement of this meeting that I first began to realize the benefits of working as a team. The decision to develop content and use technology tools to deliver it grew out of intense synergistic planning. Each of us learned to be very direct and candid about our ideas and feelings, and that practice has benefited us ever since.

Another good reason to work as a team, especially in the field of technology, is the fact that tools are proliferating at a tremendous rate and no one can know everything about every tool. Even the three of us, who spend a good portion of our professional lives working and teaching with technology, only know about certain tools. Our combined knowledge and our combined resources in people and equipment are great assets as we develop the course.

A further advantage of teamwork during this development phase is that it gives us the skills we will need for the delivery phase. As difficult situations arise, we have practice in dealing with each other. We know each other's strengths and how we each operate. This planning phase has also been integral to our understanding of how the compressed video equipment works.

Issues of Delivering a Course via Compressed Video

Wyoming is a rural state with considerable distances between towns. The University of Wyoming, the state's only four-year educational institution, is located in one corner of the state. Serving such broad educational needs is difficult. Flying instructors to remote sites is expensive and hard on the faculty. During harsh winters, driving and flying are often impossible, leading to disrupted courses. Audio teleconferencing courses are offered but have their own limitations. Our compressed video network linking eight sites has been in use for over a year now. Faculty are already enthused about the savings in travel time and money. It remains to be seen whether such savings offset other network limitations.

In reading about other compressed video networks, I have found that we are all hoping for similar advantages. Burton (1991) describes the University of Missouri's compressed video system as having the distinct advantages of:

1 eliminating travel time and expenses
2 forcing meetings to be more structured which results in more productive meetings
3 allowing the university to reach more students
4 allowing the university to reach remote areas
5 enabling the university to be perceived as being a cutting-edge, high-tech organization (p.2)

The U.S. Navy has also used two-way video training. In a recent study (Simpson, Pugh, & Parchman, 1991), it was found that student attitudes and performance on examinations were comparable in the originating and remote sites. This study had only two sites, however, and students were present in the originating site classroom. We may also have students at our two originating sites, but we will have more than one remote site. Still, these findings are encouraging.

The heart of our compressed video system is the codec. It is a coder/decoder that converts analog audio and video to a digital format. The audio quality is good, though a little low at times. Our system is prone to "hum" if any of the sites' microphones are inadvertently left on. The quality of the transmitted video is good and is just slightly slower and jerkier than full-motion video. The system does not lend itself to quick movements which result in blurs or strobe-like effects. Still images, like text or graphics, can be sent with high resolution by a specially-designed close-up camera. This camera can also send full-color slides. Built-in to our system is an MS DOS computer that can store slides on its hard drive.

Haynes and Swisher (1991) report that unpredictable and unacceptable audio is the biggest problem of the compressed video network at the University of Oklahoma.

In fact, unsatisfactory audio interaction has forced student-to-teacher and student-to-student interaction to be either minimal or artificial in their medium to large classes. They also lament the fact that although lecturing is facilitated, the free-flowing interaction of graduate education is not. I am hopeful that we can find strategies to overcome these problems.

Because the video on the network follows the dominant audio, it is important for participants to be tactful. When I have been in meetings on the network with five or six sites, I've noticed that there is a long pause between attempts to speak. This is to make sure we are not interrupting anyone else on the system, but it does make for more time-consuming meetings. We have not found, so far, that audio is a problem. We are discussing now how many sites to invite to participate in our class. If we have more sites, more sharing and network-building of technology-using teachers in the state can occur. There is also an important financial benefit to the University if we have a large group of participants. On the other hand, multiple sites can mean multiple problems. We have allowed an extra half-hour each class meeting for possible technical problems.

In our summer session, we will demonstrate each of our interdisciplinary units. During the sharing of these units, several different technology tools will be used. Authoring software like HyperCard and LinkWay, video stills, video tape, computer-based spreadsheets, data base applications, and CD ROM will all be used. Teachers will be able to choose which tools they want to learn, based on what they see in our units and what hardware and software they have available in their schools. Then we can provide hands-on instruction, which may be unwieldy over the network. If instruction proves difficult, teachers should be able to get help from their own schools' resources over the course of the summer, or we can supply them with print- or computer-based instructional modules or video tape. How difficult it will be to present hands-on instruction over the network may depend on the number of teachers and the number of sites in our class.

We experimented with various ways and means of transmitting computer screens across the network. One of the newer tools we tried was a box that converts computer signals to flicker-free TV signals, but the image on the monitor seemed to be missing several scan lines so the text was unreadable. We are still experimenting with this possibility and are optimistic that it will work with some adjustments. The most visually clear method we found was filming with the close-up camera pointed directly at a portable computer screen. It's awkward to position the close-up camera and computer this way, but it is feasible. I don't know how necessary it will be to consistently send computer screens back and forth, but we do have that option. Video stills, slides, graphics, and written material transmit easily. Video tape is a medium that also transmits well, and we can use the aforementioned box to "tape" a series of computer screens for presentation, if necessary. For readings and print-based instructions, we can mail ahead.

We know from our development meetings that group (at least small group) discussion works very well over the network. Sometimes the network is almost transparent as we become involved in our thoughts and ideas. When that happens, I am convinced that the technology is viable. When we have technical problems, like not receiving either audio or video, or both, I wonder if it's worth the time it takes to reboot the system or troubleshoot via telephone. But, happily, that happens only occasionally. When it does, though, I am reminded that audio is much more powerful than video. When we have audio,we can still communicate, plan, and make progress on our course development. When we only have video, we are relegated to hand signals and writing notes back and forth. It is not workable. A back-up speaker phone system was installed in the University's classroom and will permit us to make progress if the network goes down.

Optimistic Final Thoughts

Our team is excited about the prospect of breaking new ground in our teaching. We are enjoying the teamwork which brings with it wonderful opportunities for professional growth in both skills and knowledge. We are hopeful that our course will enable teachers to use technology to break down subject-area barriers and significantly change the culture of many of Wyoming's classrooms.

Our challenge in this course is to unleash compressed video's unique power rather than try and fit "conventional" practice to it. But this is hard as we are only beginning to discover ways to use compressed video technology. We are encouraged, however, by the tools and strategies that are being developed to help us be more effective.

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Continuing teacher education at a distance using audiographic technology

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Opportunities for continuing education for teachers in many rural schools are limited because the expertise for the training is located great distances from the communities in which they work (Knapczyk 1990; Knapczyk, Rodes, & Brush, In press). The limited accessibility to training in these communities contributes to the difficulties teachers have upgrading their professional skills and to the critical personnel shortages that many rural school districts experience (Helge, 1985; Treadway, 1984).

Creating a wider array of continuing education opportunities in rural communities presents many challenges to universities. One particular challenge is establishing close communication links with rural schools that support high quality and comprehensive staff development activities. This article describes an innovative approach to teacher education using distance education and computer-based audiographic technology. The approach overcomes many of the limitations of more traditional forms of teacher education.

Background

For the past four years we have been providing continuing education opportunities for special and general education personnel in several rural school corporations in Indiana. These activities are field-based in that the teachers remain in their home communities during the training, while the instructors stay at the university and communicate with the teachers via distance education technology (Knapczyk, Brush, Champion, Hubbard, & Rodes, 1992).

The focus of the training is on improving educational and support services to students who are high risk or mildly disabled so that they can successfully take part in school and community settings. The major goals of the program are to encourage greater communication, cooperation, and collaboration among school personnel; demonstrate effective teaching practices; promote application of the practices to the teachers' work environment; and restructure classroom, school, and community settings to offer children a wider range of educational opportunities.

A distance learning format is used to deliver the training, and teachers from schools close to one another form cohort groups for the program. Personnel from over 50 schools and agencies in 17 different communities in southern Indiana have or are currently enrolled in the program. They can upgrade their instructional skills in such areas as assessing learning and behavior problems, improving social skills, and increasing motivation.

Through our work in the program, we have come up with some solutions for improving teacher education in rural settings that we will present under the following headings: linking to the university, promoting ownership of training, improving on-the-job performance, and increasing staff collaboration.

Linking To The University

One major challenge to continuing education is minimizing the travel time and costs usually associated with traveling to a university for coursework. We found that the best solution for meeting this challenge is to develop a communication network between instructors and teachers so they can communicate with one another yet remain in their home communities. What is required here is a communication network that is diversified and flexible enough to support the demands of the training so that instructors can give formal presentations, oversee small group discussions, supervise individual practicum projects, and carry out the other functions normally associated with continuing education activities.

In our program, we use an audiographic two-way communication link that allows us to give verbal and graphic presentations, share print materials, lead discussions, and oversee field activities in which teachers apply concepts to their school settings as they learn them. Audiographics is a computer-based technology that allows instructors and students to transmit graphic images and textual information between two or more computers using ordinary telephone lines (see Figure 1). The audiographics software gives us the ability to scan overheads and other documents into a computer and transmit the images over modems to a remote location. Alternately, we can create graphics or text on the computer itself and transmit them. Teachers and the instructor can then see the images on a computer or television monitor, or on a screen by means of a liquid crystal display (LCD) projection device. For the past three years we have used an audiographic software developed by AT& T called SCANWARE that operates on a MS DOS platform. This year we are examining two software programs that run on a Macintosh platform over Apple Talk Remote Access: Timbuktu and Group Teleconferencing System (GTCS).

Audiographics allows transfer of information in real time; when we command the computer to send an image to a remote site, it appears on the screen almost instantaneously. The same is true with any type of editing or supplemental information that takes place on the computer. For example, if we want to highlight or annotate a graphic image on the computer screen, we can circle, underline, or write on the image, and the additions are immediately seen on the teacher's computer.

By using audiographic technology in conjunction with a simple speaker phone, we can conduct highly effective class sessions. The computers function as sort of an interactive chalkboard that gives the class presentations a strong visual focus without being overwhelming or intimidating to the teachers. In fact, the separation of the instructor and teachers and the absence of a typical authority figure have tended to spur much more active participation than is often seen in more passive video-style classes or even on-campus courses.

We use a team-teaching approach to deliver the classes, with two instructors taking roles roughly analogous to the "play-by-play" and "color" announcers in a sports broadcast. We have found that the use of two distinct voices in this way creates a lively and full presentation and encourages an active interchange among the teachers.

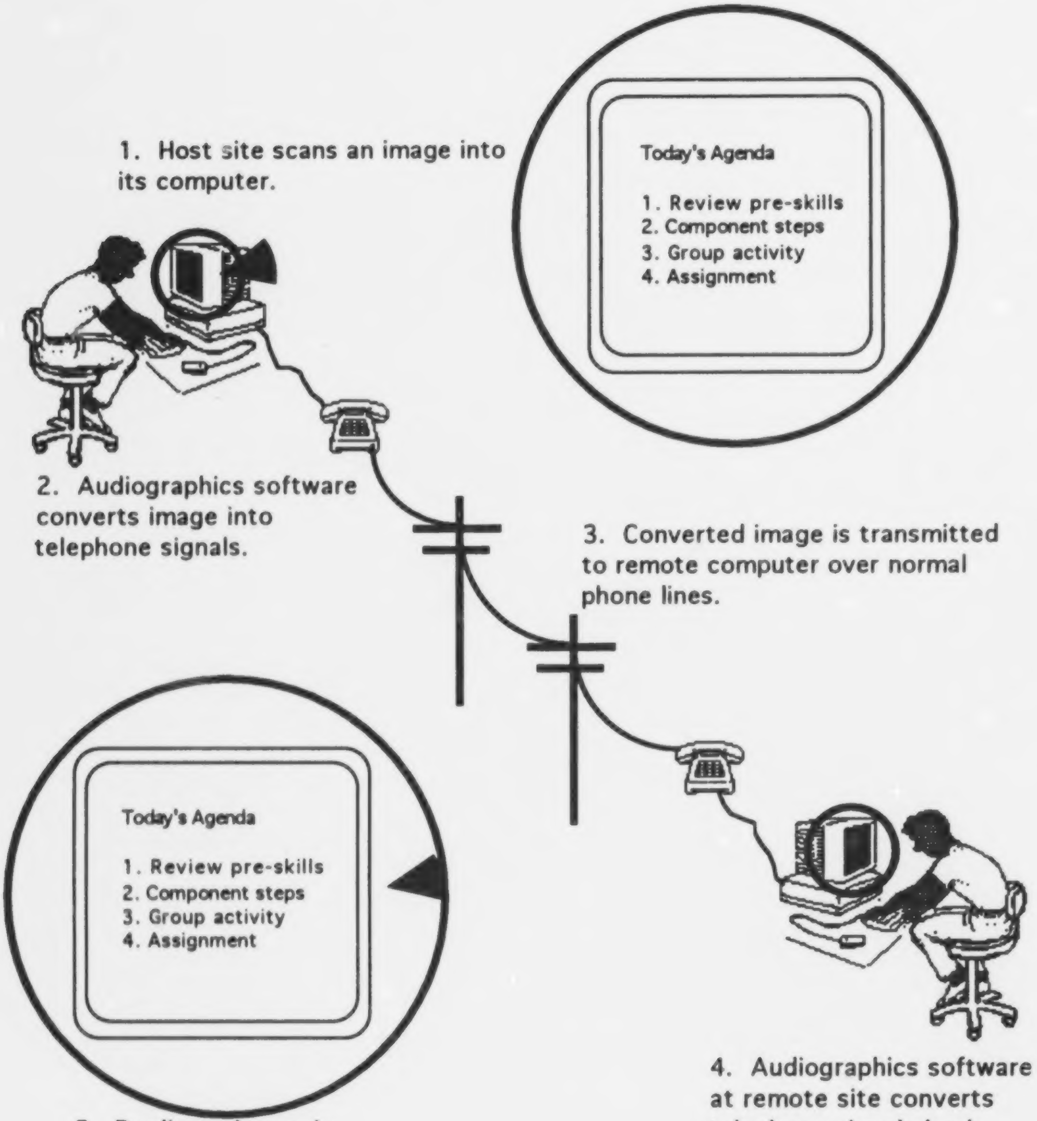
The benefits of audiographics is that it is both dynamic and economical. The interactivity that audiographics gives to a real-time distance education class can create a very animated class session. For example, we can easily scan in and transmit a sample of a particularly well done assignment, and then highlight particular aspects of the assignment by annotating, circling, or underlining key phrases and important points. Thus, we use the computer screen in the same way that an overhead projector would be used in a traditional class. However, unlike an overhead projector, the teachers could, at the same time, annotate and highlight portions of the same assignment. This level of interactivity is a major addition to a training session delivered via distance education.

The equipment needed to connect two sites together includes two computers, two high-speed modems, and the audiographics software. All of this can be purchased for under $5000, and most universities and many schools already have the required computer hardware. The only additional costs for delivering a training session would be the monthly telephone service, the long distance charges, and the price of two speaker phones. In our program, we have also purchased facsimile machines for each of the training sites so that teachers can quickly send in assignments and receive feedback on their work. This combination of low-cost, versatile, and easy to maintain equipment gives instructors many options for delivering and overseeing class activities and practicum projects (Chute & Balthazar, 1987; Knapczyk, 1991).

Promoting Ownership Of Training

Continuing education activities should also encourage ownership of the training so the teachers view the activities as a useful part of their professional development. Research suggests that teachers will assume ownership of training when the topics and activities closely match their needs and interests (Treadway, 1984). However, finding ways to promote ownership is particularly challenging in distance education programs because the instructors and staff are separated (Keegan, 1990).

In our program, we encourage ownership by structur-


Today's Agenda
1. Review pre-skills
2. Component steps
3. Group activity
4. Assignment
Today's Agenda
1. Review pre-skills
2. Component steps
3. Group activity
4. Assignment

1. Host site scans an image into its computer.

2. Audiographics software converts image into telephone signals.

3. Converted image is transmitted to remote computer over normal phone lines.

4. Audiographics software at remote site converts telephone signals back into image.

5. Duplicate image is displayed on computer or projection device at remote site.

Figure 1. How audiographics works.

ing the training as a cooperative arrangement between the university and local schools and by sharing the responsibilities for planning and delivering the training. We supply the technical expertise about the topics of the sessions, prepare the instructional materials, and participate in the meetings by means of the communication network. On their part, the school personnel assist in laying out the training activities and showing the staff how to use the information in their classrooms and schools. We accomplish this aim by having one of the teachers serve as an on-site coordinator for the sessions who helps plan the training, oversees the practice exercises, and monitors the small group projects.

There are several ways in which we and the teachers have benefitted from sharing responsibilities for the training. First, the on-site coordinators give input into the planning of the program because they can assess the specific needs of the teachers. They identify the topics that need particular emphasis and explain how the topics can be tied to the policies and procedures of the schools. Second, the coordinators personalize the instruction by giving examples that pertain to the topics and explaining how a procedure can be used with a particular student or in a situation that all the teachers are familiar with. The coordinators lead in-class discussions and small group activities and elaborate on the points that are covered in the sessions. Finally, the coordinators provide us with detailed feedback about the training so we can modify the sessions and plan follow-up activities. We have found that by sharing the responsibilities for the training in these ways, the teachers become an integral part of the training experiences.

Improving On-the-Job Performance

The primary goal of continuing education is to improve the teachers' on-the-job performance. However, all too often, continuing education activities are comprised of "one shot" efforts that do little to actually upgrade the teachers' classroom teaching skills. One of the best solutions for improving on-the-job performance is to provide activities in which the teachers apply the concepts immediately to real life situations. This "reality check" shows the teachers that the training is both practical and useful for them.

In our program, we combine instruction in methods and techniques for working with students with highly relevant practicum activities; activities which the teachers complete in the context of their own classrooms. For example, in our module on social skills training, we discuss different strategies and techniques for identifying and assessing students having problems with their behavior, and the teachers immediately apply these procedures with their own students. In this way, they not only learn methods for reducing problems in social behavior, but also use these methods with their own students.

We also encourage carryover of the training by having follow-up sessions after the teachers have tried out the ideas or techniques in their programs. In the follow-up sessions we can oversee both the planning and the actual implementation of practicum projects. We can give teachers feedback about their projects and clarify the procedures they are learning to use, thus providing valuable information about applying key concepts to their job situations.

Increasing Collaboration Among The Staff

Finally, continuing education activities should foster stronger collaboration among the staff and give teachers a common set of experiences that they can use for classroom-, school-, or district-based planning efforts. In-service training should provide opportunities for the staff to share their experiences and expertise with one another and to form task-oriented work groups that address issues pertaining to improving educational services (Slavin, Karweit, & Madden, 1989).

We further collaboration among the teachers by having them complete case study projects as school-based teams. These projects give teachers with similar backgrounds or common concerns opportunities to solve instructional problems that are especially important to them. For example, in a project on mainstreaming special education students, the teams consider the impact of mainstreaming at their particular grade levels and plan solutions for overcoming anticipated problems. Then, as they carry out the projects, the team members serve as a resource to one another and work together to upgrade this particular aspect of the school's program. Such activities increase communication and cooperation among the teachers and help them realize that providing educational services requires a team effort based on mutual professional support. Collaboration among the staff is an important factor in this process because it ensures that the training has a long lasting effect on improving educational programs (Thousand & Villa, 1989).

Conclusion

Continuing education presented through distance education can give teachers opportunities to upgrade their skills when more conventional forms of training are not available to them. However, the staff members in the schools must take a very active part in planning and delivering the training so that it is practical and useful to them. Distance education and communication technology can give universities tremendous flexibility in offering training experiences that are well-suited to the needs of rural communities. Distance education and technology can turn the challenges of continuing education into decided advantages by allowing training institutions and school corporations to share the responsibilities for teacher preparation.

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Training distance educators for converging technologies

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Background

The purpose of this paper is to describe how instructional designers, teachers and trainers are trained in the Department of Educational Technology at San Diego State University to use integrated voice, video, and data with desktop workstations for distance education. Distance education has its early roots in correspondence education (Pittman, 1990), and its more recent origins are in instructional radio and television. Although experimentation with educational broadcasting in the 1960's and the 1970's showed mixed results in effectiveness (Saettler, 1990), a report published by the Office of Technology Assessment (OTA) is more positive about its current applications in schools. According to the report, what makes present attempts different from earlier ones is the role of distance education in providing culturally diverse and geographically dispersed groups of students with mandated instructional services that would not have been available to them otherwise (US Congress, 1989).

Also, the emergence of new computer-based integrated voice, video, data systems make the future applications of distance education more promising. These systems provide live, interactive multimedia communications (Hargadon, 1992; Reveaux, 1992). Working at a distance, the instructor and the student can see each other, share the same screen and computer file, and talk to each other. Like other technologies which have emerged and found their way into the classroom, widespread use of integrated telecommunications systems in schools is just a matter of time. For example, the California Master Plan for Educational Technology (California Planning Commission for Educational Technology, 1992) calls for the development of the Golden State Education Network, which is "an integrated voice, video, and data link of existing networks" p. 11. The network will connect public schools with institutions of higher education so that educators could better integrate technological solutions into curriculum and instructional programs.

These developments indicate that trained educators who are familiar with theoretical and practical aspects of converging technologies will be needed to design instruction for integrated systems to be used by learners in public schools, in the private escort, and at home. Such professionals should be able to:

- Design programs for converging technologies,
- Use converging technologies to deliver instruction,
- Provide support services to distant learners via convergent systems,
- Conduct evaluation and research studies on distance education concepts, models and programs, and
- Analyze the impact of new information technologies on society, education and schooling.

Anticipating these developments and needs, a course was designed in the Department of Educational Technology, San Diego State University to instruct teachers and trainers, enrolled in the graduate program, how to use integrated microcomputer-based telecommunications for instructional purposes. The course, titled *EDTEC 651, Seminar in Distance Education*, enables students to use a desktop workstation and its related telecommunications and computing features to design, develop and present live interactive distance education programs. Students learn how to use voice, text, graphics and video communications to design, develop and present telelessons. They use a prototype integrated desktop workstation consisted of a Macintosh computer, a telephone and a video loop to deliver instruction. Also, they use HyperCard to create authoring shells and Timbuktu to present telelessons (Saba & Twitchell, 1988). Furthermore, they are engaged in learning activities that allow them to become familiar with theories of distance education, research and evaluation methods and current issues in the impact of new telecommunications technologies on society in general, and on education in particular. Course objectives include:

1. Identify various parts of a typical integrated desktop workstation and describe the functions of each part.
2. Use a desktop workstation to establish bi-directional, synchronous and shared voice, computing and video telecommunications with another desktop workstation.
3. Develop an authoring shell in HyperCard.
4. Develop and present a telelesson via Timbuktu with HyperCard.
5. Compare strengths and weaknesses of various telecommunication systems.
6. Name key organizational functions of a distance education provider.
7. Investigate a current issue in theory of distance education, or in research and evaluation methodology, or in the impact of new information technology on society and education.
8. Participate in an computer teleconference to discuss selected issues.

Theoretical Foundation of the Course

Theoretical foundation of the course is based on the concept of transactional distance (Moore, 1983) and its elaboration by Saba (1990). According to Moore, transactional distance is a function of two factors: dialog and structure. Dialog is "the extent to which, in any educational programme, learner and educator are able to respond to each other." Structure is "a measure of an educational programme's responsiveness to learners' individual needs" (Moore, 1983, p. 171). Transactional distance is a function of the variance in dialog and structure in relation to each other; therefore, "distance" in education is not determined by geographic proximity, but by the level and rate of dialog and structure (Saba 1990).

Based on these definitions, in a previous study, a dynamic model of distance education was proposed. This model suggested a dynamic relationship between structure and dialog as in the following diagram:

> According to this causal loop diagram, in integrated distance education systems as dialogue increases, structure decreases and as structure decreases, dialogue increases to keep the system stable... In a plausible scenario, the need for decreasing structure is communicated to the teacher. Consultation automatically increases dialogue; then adjustments in goals, instructional materials, and evaluation procedures occur and the learner achieves the desired level of autonomy (Saba, 1990, p. 350).

Students are informed that in a current study by the author the level and the rate of dialog and structure are measured by discourse analysis in specific time intervals. This is to provide raw data for a mathematical model of a computer simulation technique called System Dynamics (Roberts, 1983). Using System Dynamics, the relation-

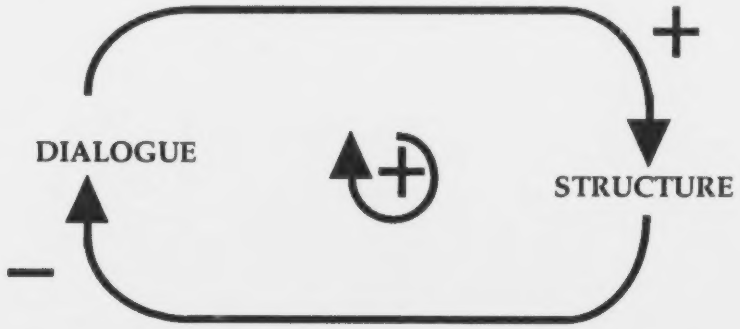

Figure 1. Causal loop diagram of transactional distance.

ships among the two key variables under study are simulated to determine how the increase or decrease in one system variable affects transactional distance. For example, it will be shown if a decrease in dialog during a telelesson would result in an increase in transactional distance. A Macintosh computer version of the software called STELLA (Highe Performance Systems, 1992) is currently used to run the model in pilot and actual runs.

In the course, the concept of transactional distance is used to analyze existing distance education systems and propose new ones. The primary emphasis, however, is on how the concept can be used in designing new integrated distance education systems.

General Approach of the Course

Students learn how to design effective distance education systems by dividing the task in three different levels. Level I is concerned with the general organization of distance education systems (meta design). Case studies are presented to identify organizational components of such systems. The function of each component is described and analyzed. The same case studies are used to identify and select appropriate needs assessment strategies for distance education services. Examples are presented to show the historic role of distance education in mitigating organizational needs in private and public sectors; social inequities in urban and rural areas; and inadequacies of extant educational systems in industrial and developing countries.

Level II is concerned with the macro design of the telelesson. Students have to decide on the amount of dialog and structure which they think would be most appropriate for the content of the telelesson and the learner's profile. These decisions are materialized in a HyperCard shell which they produce to present the content of the telelesson. Students use their previously acquired skills in HyperCard for creating stacks which they use to display and present instruction. These stacks often provide for presenting instructional content with voice, text , graphics and video; specifying the instructor's role; indicating learner activities; and responding to learner's queries.

Level III is concerned with micro design of integrated systems. Instructional design decisions at this level relate to fonts, graphic displays, video segments and audio communications. Particular attention is paid to screen design for the computer display and the video screen.

An important feature of the course is familiarizing students with advanced standards in integrated telecommunications systems. Telecommunications is a very rapidly changing field. Although students in EDTEC 651 rarely will become engaged in designing networks, a knowledge of telecommunication systems is essential for them to conceptualize and integrate technological solutions into the curriculum and instructional activities. Through class presentations and discussions they become able to compare the strengths and weaknesses of traditional and new telecommunications systems and standards. Systems such as cable television, microwave transmission and satellite television are analyzed and discussed. In addition, instructional time is devoted to the introduction and analysis of emerging telecommunications standards such as Integrated Services Digital Networks (ISDN). Discussion of telecommunications systems enable students to analyze existing systems and design appropriate distance education programs for use by teachers, trainers and students in schools, in business and industry and at home.

Social impact of emerging telecommunications technology is also scrutinized. Trends in transforming the society from an agro-industrial one to an information based community are discussed and analyzed. Educational ramifications of this historic transformation for public schools, business, industry and home are probed. Particular attention is paid to *The Good Society* by Bella, Madsen, Sullivan, Swidler, & Tipton (1991). Students are assigned to read this book and participate in an asynchronous teleconference. The book discusses current problems of major societal institutions and provides a vast array of issues for discussion. Since it does not offer specific solutions or ideological remedies for current social ills, it is ideal for class discussion purposes. In order to better prepare students for their future careers, the discussions on this book are conducted on-line with students working at home instead of being present in a class on campus. Students, who primarily use Macintosh computers, access a mainframe computer from home. A software application, VaxNotes, allows students to conduct asynchronous teleconferences via their home computers and a Vax computer located on campus. The conference software enables students to comment on different chapters of *The Good Society* as well as to read comments left on the system by their peers. In this way, each student is informed of everyone else's ideas and opinions regarding the ideas presented in the book. The teleconferencing system provides an opportunity for expanded peer interaction far beyond what normally transpires in the so-called "face-to-face" classroom instruction.

Class Activities

EDTEC 651, Seminar in Distance Education is a graduate course. (Syllabus of a previous iteration of the course, EDTEC 700, can be found in Seidman, 1989). Those students who have completed at least one course in three areas of instructional design, educational television, and hypermedia production can enter the course. Through a series of demonstrations and laboratory exercises, students receive hands-on instruction on how to use the voice, video and computing features of the desktop workstation; and establish and maintain communications with at least one remote desktop workstation. As students are already familiar with HyperCard (Allen, Dodge, & Saba 1990) and have learned how to produce and use video clips in prior courses, they can quickly learn how to use the desktop workstation for establishing bi-directional and synchronous communications with their learner working at a remote desktop workstation. The only new feature to them is Timbuktu, a communications software that enables the instructor to share his/her hard disk drive with the learner for a variety of different computing purposes, including screen sharing and file transferring. Timbuktu is a user friendly software and its use becomes transparent to both the instructor and the learner after a few minutes of initial exposure.

Once students have become familiar with basic communications and computing features of the workstation, they form groups of 3 to 5. They are provided with instructional design guidelines to produce a HyperCard shell as an authoring template for designing, developing, and presenting telelessons; and for managing on-line instructional systems. Within the confines of the guidelines, they are encouraged to use their creative talents to include features in the template that would help them to strike an appropriate balance between dialog and structure, as well as to maintain good communications with learners for administrative and counseling purposes.

Authoring templates are presented in class and students receive feedback from their peers and instructor. Once the templates are refined, each student selects a content area, or an administrative/counseling procedure for designing, developing and presenting a program. Final projects are delivered "live" and on-line as students teach their learners a combination of facts, concepts, procedures, rules, principles, or theories related to selected content areas. As students are free to experiment with a wide variety of content areas, final projects have ranged from teaching techniques of shot composition with a video camera, to administering acupuncture. Final projects are evaluated by the instructor as each student delivers his/her program. The evaluation form contains criteria related to meta design, or the organization and administration of a system; macro instructional design, or instructional strategies and the balance between dialog and structure; and micro design or font selection, text density, and the design of graphics and audio and video segments.

Students' Response

EDTEC 651, has been offered on an experimental basis for the past three years. Each year, students have received it with enthusiasm, dedication and hard work. They feel they are contributing to the future development of the field of distance education by developing and presenting demonstration projects on a new technology. Because of its success, the department will offer the course on a regular basis in the future.

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Evaluation of distance learning

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The Teacher's Role in Evaluating Distance Learning

One of the most exciting aspects of distance learning is its potential for innovation. Distance learning has been used for many worthwhile purposes, from providing educational services to the homebound student to allowing inner city students to electronically attend dress rehearsals at Lincoln Center. Indeed, this flexibility and innovation may be the most important reason that distance learning is such an exciting technology in education.

Education as a field, however, is not known for its rapid acceptance of innovative approaches. Most teachers are still without even the basic electronic necessities enjoyed by other professionals, for example, a class telephone. Reasons for this apparent failure to adopt educational innovation are varied and range from the trivial to the serious. While some K-12 administrators reportedly believe that a telephone in the classroom will be misused, most administrators fail to quickly accept educational innovation simply because they want to be very sure that any new program, service, or curriculum is approached with the caution which is necessary to prevent potentially detrimental pedagogical methods from harming students. This attitude and position is, of course, perfectly correct in terms of protecting the right of students to receive as effective an education as can be provided.

The process of testing new educational approaches before they are adopted is rightfully deliberate and often slow. While this paper is not the appropriate forum to discuss the ongoing problems which exist with various types of testing, student scores of some type are most often used to review educational innovation; i.e., to demonstrate whether or not and to what degree students actually learn via a given approach. Tests of student knowledge can range from national standardized tests to teacher-developed quizzes. These methods can be a valuable means of determining distance learning's effectiveness in producing acceptable student learning.

Student Tests and the Relationship to Student Learning

When a new educational approach such as distance learning is undertaken, the degree to which students actually learn must be assessed. And, good or bad, most teachers continue to rely on test scores to assess student learning. Educational evaluators, who must work closely with teachers, also often rely on student test scores to determine the efficacy of given educational approaches. This makes sense for several reasons. If a student's test score (or an aggregate of scores) is used by educators to decide whether or not a student should be promoted, these scores can certainly be used by evaluators to determine the effectiveness of the approach which produced these scores. Additionally it is more efficient for evaluators to employ testing methods teachers use so that teachers will not have to devote additional time and energy to designing, administering, and/or grading tests designed specifically for the evaluation.

In the best scenario, pre and post tests might be administered to students enrolled in the experimental approach as well as in a matched class of students who are being taught traditionally. While this is clearly desirable, it seldom happens in the real world because two classes of students taking the same specific course are seldom matched on all variables known to be important educationally. However, because evaluators and/or educators must demonstrate that new educational approaches are or are not effective, some type of comparative student assessment is necessary.

Fortunately, in regular K-12 courses such as French I, another class at the same level (e.g., 10th grade) is typically taught traditionally. In fact, due to the public and, therefore, standard provision of textbooks throughout a district, the books used for all French I classes are probably the same. Therefore, students are matched in terms of teaching materials and grade levels. Using student records already available, evaluators can determine whether or not the students are matched on other important variables. Evaluators are often able to find these situations. However, evaluators who wish to use such a matched design must work closely with teachers to identify these comparison classes at the beginning of the year.

Once the matched classes have been identified, an appropriate test must be selected. What can be done if the traditionally taught, matched class cannot be pre-tested because the classes cannot be identified before school begins? This is a common situation which occurs when the availability of distance learning or another technology is not known until school actually opens.

In such a case, the educator and evaluator can still work together to identify a traditionally taught class against which the distance learning students' educational outcomes can be compared. That is, final post-test scores and/or grades can be obtained in this situation; however, pre-tests scores cannot be collected. In lieu of these pre-test scores, beginning student grade-point averages (GPAs) can be used. That is, if the average GPAs of the traditional and distance learning classes do not differ significantly, the evaluator can predict that students in the two types of classes will not differ regarding final test scores. This method, while clearly not as rigorous as a pre-post test design for student groups matched on all significant variables, is useful in many distance learning situations.

Testing Alternatives

If formal, written tests are not used to determine students' educational outcomes, the evaluator and the teacher should discuss the specific methods which are used to determine student success. The evaluator should be willing to accept whatever method the educator uses. If the teacher typically uses oral presentations to assess student progress, the evaluator should also be willing to accept this method of judging student success. If a teacher promotes or fails a student based on a given assessment method, this method is also defensible for evaluation purposes.

Student Privacy

Before any method of judging student effectiveness can be selected, evaluators must work with educators to ensure that student privacy is protected. While the degree to which such privacy is protected varies from school to school, the Federal Privacy Act of 1974 mandates that such protection is provided in all situations in which public funds are spent. The evaluator must assume primary responsibility for this issue and must prompt serious discussion of the matter with appropriate educators and administrators. Some school systems have developed procedures to protect student privacy and these must obviously be identified and complied with before any student information is released. Even in schools and districts in which no formal policy is enforced, evaluators must make every effort to assist teachers and ensure that student and teacher rights are protected. The 1974 Privacy Act mandates that every data collection instrument and procedure clearly describes specifically who will use the data and for what specific purpose. Additionally, every data collection form should ensure in writing that no individual respondent will be identified as a part of the study; i.e., that data will only be presented in aggregate. Finally, any data collection form must also contain a statement which explains a respondent's right to withdraw from the study at any time.

While it is admittedly time consuming for an evaluator to identify and address each of the issues discussed herein with each educator involved in a given project, failure to do so is clearly unprofessional.

Teacher/Evaluator Agreement

Teachers may not accept evidence that a specific program or service was effective if they had no input about the best ways in which such effectiveness could be assessed. Nor should teachers have to bear the burden of explaining a student's involvement in an innovative or experimental educational approach—and its evaluation—to parents. Parents are concerned about their children's right to an effective education and their right to privacy. It has been the experience of this evaluator that both teachers and parents appreciate the attention to student rights which is reflected in the activities described above and that parents, teachers, and students are willing to provide data which they are aware will promote effective schools.

Conclusion

The future of distance learning and other innovative educational technologies seems bright; however, it is imperative that this future actually be demonstrated in terms of positive student outcomes resulting from such innovations. Evaluators must work closely with teachers to guarantee that this occurs.

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SIMULATIONS

In reviewing the papers included in this section, we were reminded of the dramatic progress that educational technologists have made over the past few years (1) in developing ways to deliver feedback to learners and (2) in expanding the scope of the feedback that is delivered. Twenty-one years ago, our research at the University of Virginia centered on providing elementary students with feedback-laden remedial reading instruction which was administered by a teaching machine that was literally tied together with government surplus relays and timers (Strang, 1972). In the early 1980s, a simulation program stored on an eight-inch floppy disk provided our first group of preservice teachers with very simple feedback on their "basic teaching skills." By the late 1980s, we were able, with the help expanding computer technology, to introduce our preservice teachers to a class of simulated pupils who "provided feedback" to many teacher actions in ways that emulated live students (Strang, Badt, & Kauffman, 1987). We are currently moving toward a goal that will further enable us to extend the scope of the feedback provided to our preservice participants. Research is underway to discover the teaching styles that students employ as they complete simulated lessons. Once such styles are isolated, the feedback provided during simulations can change from universal listings of behavioral frequencies to customized profiles that are specifically designed to help individual students to better achieve their "unique potentials" as teachers.

The use of state-of-the-art technology to provide powerful feedback to learners is also a prominent theme in the remaining three papers found in this section. At the University of Southern Mississippi, Rae Schipke is developing flexible simulations for local area networks (LAN's). In the prototypic simulation on giftedness which Schipke describes, the interplay of assigned teacher, students, observers and experts during the teaching phase promotes powerful collective feedback—feedback that helps the students to begin to understand the distinct roles that different participants play in the teaching experience. The simulation's debriefing and follow-up phases also offer a variety of opportunities for procuring additional relevant feedback.

At the University of Maryland at College Park, Judith Torney-Purta is working with the International Communications and Negotiations Project (ICON). This innovative project employs computer networking and a carefully planned structure to encourage adolescents to learn more about major world issues. Rich sources of feedback are provided via the project's reliance on focused peer exchanges.

In the final paper, Dora Perry-Wilson extends the envelope of feedback to embrace nonlinear science. Three feedback loops are provided to illustrate her approach to interdisciplinary curriculum design.

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Exploring teaching techniques via A microcomputer simulation

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Introduction

Since the early 1980s, research conducted at the Curry School of Education has demonstrated that microcomputer simulations can be used to teach a variety of instructional and behavior-management skills to preservice teachers (see Strang & Loper, 1983-84; Strang, Murphy, Kauffman, Badt, & Loper, 1986; Strang, Badt, & Kauffman, 1987). Development efforts over this period have produced teaching simulations that have become increasingly more realistic in offering participants options for interacting with software-defined pupils who, themselves, have increasingly acquired many of the characteristics of their live counterparts. Paralleling these changes, the feedback provided to participants has expanded from simple lists of basic skill proficiencies to profiles which offer more comprehensive information on teaching strategies. The current study was designed to define the major techniques that preservice participants use in addressing the challenges encountered in the current Curry Teaching Simulations.

Research Goals

At present, a pool of over 200 variables define various aspects of a participant's simulation experience. The purpose of the current study is:

1. to identify major clusters of performance variables that define distinct teaching techniques of the preservice participants who complete theteaching simulation; and
2. to test for relationships between the teaching techniques and

a. personality traits as derived from the Myers-Briggs Type Indicator (MBTI), Form G (Briggs and Myers, 1977), and
b. demographic variables including gender, age, teaching experience, and teaching specialty.

The MBTI was selected as the personality-measurement vehicle because it assesses historically significant personality variables, provides information that students find useful, and is relatively easy to administer and score.

It is anticipated that the results derived from the current project will contribute to the discovery of distinct teaching styles defined by the interplay of behavioral, personality, and demographic variables. As we learn more about these styles, we will be better able to assist teacher educators to develop training experiences that nurture the personal strengths of their students.

Project Description

A pilot phase of the project was completed during the fall 1991 academic semester. Subjects included 75 preservice teachers enrolled in a learning and development course taught at the Curry School. To complete one of the laboratory assignments for this course, each subject assumed the role of a teacher and conducted a lesson consisting of an unfolding series of dialogue exchanges with a class of 12 software-defined pupils. These pupils were preset to display levels of initiative, content preparation, and a propensity to exhibit common misbehaviors similar to that described by Strang, Landrum, & Ulmer (1991). Performance variables from the fall 1991 data set were submitted to principal components factor analyses performed with the PC version of SPSS (Norusis, 1990). When three interpretable performance factors emerged from these initial analyses, it was decided to conduct a more comprehensive study in this area.

During the fall of 1992, each of 135 students, drawn from the same course described in pilot study:

1. completed a 126-item paper-and-pencil instrument, Form G of the MBTI, several days before beginning the laboratory portion of the exercise;
2. conducted, during the laboratory session, a simulated lesson similar to that described in the 1991 pilot study;
3. completed a post-simulation questionnaire which included demographic and simulation-evaluationitems; and
4. received a short debriefing during which a teacher trained in MBTI interpretation discussed the subject's performance on the personality device and on several computer-generated instruments which depicted lesson-related teaching and behavior-management response patterns.

Subjects usually completed both the initial paper-and-pencil and active participation phases of the assignment within a two-hour time period.

Characteristics of the lesson. Each subject completed one of two parallel forms of the simulation the length of which was defined by 50 distinct teacher-simulated pupil interactions. Lesson content consisted of 16 spelling words and 16 math problems. The six male and six female pupils varied in the following ways.

Initiative. Four of the 12 pupils were preset to express a desire (via raised hands) to participate in lesson-related activities; eight pupils were preset to express no initiative.

Homework preparation. Four pupils were preset to answer correctly, prior to any prompting, any content-related questions that the teacher posed; eight pupils were preset to answer incorrectly.

Misbehavior. Four pupils were preset to emit a total of 10 daydreaming misbehaviors; four other pupils were preset to emit a total of 10 talking-out misbehaviors. Misbehaviors were preprogrammed to occur in clusters—that is, one daydreaming and one talking-out misbehavior always began during the same teacher-pupil interaction.

A casual review of the pupil characteristics settings clearly reveals that during their laboratory teaching session the participating preservice teachers faced demanding instructional and behavior-management challenges.

Results

Teaching techniques factors

A principal components factor analysis with a varimax rotation was applied to the simulation performance scores of 1992 participants. This procedure isolated the same three teaching techniques factors, each defined by five variables, that had been isolated in the 1991 pilot data set. Factor structure similarities across the two years were assessed by comparing *coefficients of congruence* (Gorsuch, 1974, pp. 253-254). Coefficients for corresponding factors ranged from .91 to .95, and for noncorresponding factors from -.08 to +.09.

The following descriptions outline the five variables that constitute each of the three factors.

Factor 1: Misbehavior intervention (effective behavior management versus ineffective behavior management).

Scores on this factor define how the teacher addressed behavior management during the lesson. A high factor 1 score indicates that during the simulated-teaching session:

1. the teacher maintained a high rate of total class attention during the lesson;
2. the teacher's first attempt to intervene misbehavior was apt to be effective;
3. the teacher spent relatively brief amounts of time in remediating talking-out misbehavior;
4. the teacher rarely used the ineffective intervention technique of reprimanding pupils for misbehavior; and
5. the teacher rarely used the ineffective intervention technique of becoming involved in off-task verbal exchanges with misbehaving pupils.

A low score on this factor defines ineffective teacher misbehavior management which is illustrated by the converse of the effective pattern.

Factor 2: Instructional delivery (pupil-oriented instruction versus task-oriented instruction).

Scores on this factor define how the teacher structured the lesson. A high factor 2 score indicates that during the simulated-teaching session:

6. the teacher was apt to ask the class to "take a moment and think about how to answer" a particular question;
7. the teacher was apt to seek out volunteers to participate;
8. the teacher was apt to ask the class to indicate who was prepared to answer a content-based question;

9. the teacher was not apt to introduce a new content item by asking a pupil to render an answer; and
10. the teacher was not apt to solicit answers from a pupil who was not ready to respond correctly.

A low score on this factor defines a pattern of instructional delivery which is more mechanical—a pattern which illustrates the converse of the pupil-oriented approach.

Factor 3: Activity sequencing (proactive teaching style versus a reactive teaching style).

Scores on this factor define the degree to which the teacher controlled the sequencing of activities during the simulated lesson. A high factor 3 score indicates that during the simulated-teaching session:

11. the teacher was apt to spend a relatively long period of time in completing each lesson-related event;
12. the teacher was apt to show a relatively long latency before attempting to intervene a misbehavior;
13. the teacher was not apt to interrupt class activity to intervene a non-disruptive daydreaming misbehavior;
14. the teacher showed little variability in the number of interactions conducted with pupils requiring remediation; and
15. the teacher was not apt to respond to other class concerns without first attempting to assist a pupil who had rendered an incorrect answer.

A low score on this factor defines reactive decision-making teacher behavior which illustrates the converse of the proactive pattern.

Table 1 presents the factor loadings from the fall 1992 data set for the 15 variables that constituted the three factors.

Myers-Briggs Type Indicator results

Four personality measures are derived from the MBTI. Note that the scoring of the instrument forces a choice on each scale, but some preferences are too slight to be reliable for research purposes. Standard scoring conventions were used to assign each subject to one of the three categories for each scale. Note that incomplete data for one subject resulted in a sample size of 134 for analyses which involved personality and/or demographic variables.

Extroversion (E) versus Introversion (I). This scale indicates whether an individual prefers to focus on the external world (E) or on the inner world of thoughts and ideas (I). Sixty-four subjects showed a clear extroversion preference, 50 showed a clear introversion preference, and 20 failed to show a clear preference.

Sensing (S) versus Intuition (N). This scale indicates whether an individual prefers to gain information about the world from sensory (S) experiences or from intuitive (N) processing. Forty-four subjects showed a clear sensing preference, 58 showed a clear intuitive preference, and 32 failed to show a clear preference.

Thinking (T) versus Feeling (F). This scale indicates whether an individual prefers to make decisions based on objective (T) or on subjective (F) criteria. Twenty-eight subjects showed a clear thinking preference, 80 showed a clear feeling preference, and 26 failed to show a clear preference.

Table 1
Rotated Factor Matrix for 15 Simulation Performance Variables

Variable Number	Factor 1 Loadings	Factor 2 Loadings	Factor 3 Loadings
1	**.73**	.12	-.02
2	**.87**	-.07	.18
3	**-.59**	-.09	.31
4	**-.68**	-.02	-.11
5	**-.76**	.09	-.17
6	.19	**.68**	-.00
7	.07	**.66**	.03
8	-.13	**.66**	-.35
9	.15	**-.79**	-.04
10	-.05	**-.61**	-.20
11	.25	.10	**.59**
12	-.11	.13	**.73**
13	-.25	.23	**.63**
14	-.22	.06	**-.48**
15	-.06	.23	**-.49**

Judging (J) versus Perceiving (P). This scale indicates whether an individual prefers closure (J) or is comfortable with open-ended situations (P). Sixty-nine subjects showed a clear judging preference, 42 showed a clear perceiving preference, and 23 failed to show a clear preference.

Demographic variables

The following three demographic variables were gathered from the MBTI form, from teacher education program records, and from the end-of-session questionnaires completed by each subject.

Gender. The subjects participating in the fall of 1992 included 113 females and 21 males.

Age. Ages of the preservice teachers ranged from 19 years to 41 years. The mean age was 21.6 years with a standard deviation of 3.4.

Teaching specialty. Forty-three subjects were enrolled in the elementary program area, and 61 were enrolled in secondary program areas. On the secondary level, 6, 12, 17, 16, and 10 subjects were majoring in science, math, English, social studies, and foreign language, respectively. Eighteen subjects were enrolled in special education, and 6 were enrolled in physical education. Six subjects could not be classified into a single category, usually because of multiple majors.

Regression analyses

Stepwise multiple regression procedures were used to examine (a) which of the four personality variables and (b) which of the three demographic variables showed unique contributions to the three technique factors, each of which was defined by factor scores (Norusis, 1990, pp. B67-B68). Note that each teaching specialty category was treated as a dummy variable (see Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975, p. 374).

Misbehavior intervention. The overall regression equation for the misbehavior intervention factor was significant ($p<.01$) and explained 8.8% of the variance for that factor. The sensory versus intuitive variable accounted for a significant 3.4% of unique variance ($p<.04$). Students high in intuition were more likelyto employ effective behavior-management techniques than students high in sensing. The gender variable accounted for a significant 3.2% of the remaining unique variance ($p<.04$). Female subjects were more likely to employ effective misbehavior intervention techniques than were males. Finally, the age variable accounted for 2.2% of the remaining unique variance ($p<.08$). Older subjects were more likely to employ effective misbehavior intervention techniques.

Instructional delivery. The overall regression equation for the instructional delivery factor was significant ($p<.01$) and explained 11.7% of the variance for that factor. The math major variable accounted for a significant 5.5% of the unique variance ($p<.01$). The science major variable accounted for a significant 6.2% of the remaining unique variance ($p<.01$). Students majoring in math and students majoring in science were more likely to use task-centered instruction than were students majoring in other areas.

Activity sequencing. The overall regression equation for the activity sequencing factor was significant ($p<.01$) and explained 11.8% of the variance for that factor. The age variable accounted for 8.9% of the unique variance ($p<.01$). Older subjects were more likely to demonstrate proactive teaching styles. The physical education major variable accounted for a significant 2.8% of the remaining unique variance ($p<.05$). Students majoring in physical education were more likely to exhibit a reactive teaching style during their simulated teaching than were students majoring in other areas.

Discussion

The identification (and replication) of the teaching techniques factors represents the most significant finding of this study. These clearly defined measures address three fundamental classroom techniques—what a teacher does when pupils misbehave, what a teacher focuses on during instructional delivery, and what motivates a teacher's future actions: intrinsic planning or external demands linked to pupil behavior.

The results of the regression analyses further reveal that personality and demographic variables are tied to the three behavior-defined factors. The sensing versus intuition and gender variables predict how a subject will manage misbehavior, and three of the teaching specialty variables predict how a subject will deliver instruction and/or sequence classroom activities. Age also is a predictor of classroom sequencing. These findings stimulate interesting speculations on issues ranging from the dynamics of why students choose and are accepted into specific program areas to the impact that these program areas have in developing distinctteaching styles in students. As indicated in the results, however, most of the variables discussed accounted for a relatively small amount of total regression equation variance. An expanded replication of the current study will be conducted during the 1993 academic year. We will continue to investigate the relationship between student gender, age, and program area and the three teaching technique factors described in the current study. In attempting to expand our understanding of the three technique dimensions, the current variable pool will be expanded to include additional personality measures of self-efficacy and personal optimism, as well as demographic measures of academic performance and previous experience in working with children. In addition, we will search for links between the ways subjects communicate via complete text statements with simulated pupils (see Lawson & Strang, 1993) and their teaching techniques scores.

Research on the three teaching techniques factors must also be extended to include field studies. Such research will ascertain whether the techniques that preservice teachers employ during the completion of a simulated lesson are the same as those that they will employ in real classrooms.

Acknowledgements

This study was partially supported by funds furnished by the Commonwealth Center for the Education of Teachers, University of Virginia and James Madison University.

The authors wish to thank Susanne DeFalco and Caroline Cunningham for their help in conducting this study.

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Microteaching in microworlds: Using LAN's and simulations in preservice teacher education across the curriculum

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Overview

There is no point in work
Unless it absorbs you,
Like an absorbing game.
If it doesn't absorb you,
If it's never any fun,
Don't do it.

D.H. Lawrence

As the complexities of instructional technologies and classroom contexts shift, it is important that we help preservice teachers to understand the social and technological forces that are shaping classrooms and reshaping teaching. These forces, brought about in part by LAN technology, interactive writing software, and their attendant social demands, create new pressures for teachers and require dramatic changes in how teachers need to be prepared to deal with the added social and technological factors. "Not only do they have to become skilled in collaborative writing pedagogy, they also have to become proficient in the nature and nurture of small group dynamics and development, network pedagogy and management, and instructional planning skills that involve incorporating computers and cooperative learning strategies into the. . .curriculum" (Schipke, in press-a). It is important, therefore, that we help teachers to see teaching with technology as a continuous process of adaptive behavior, and to appropriately reshape and alter their views about learning and the resultant teaching strategies. Creating "micro worlds," or synthetic computer teaching situations in whichteachers can gain hands-on experience in planning, observing, and assessing instruction, is an important first step. When these instructional skills are taught in juxtaposition with the technology, they further the development of computer-prepared teachers. These technological teaching environments offer tremendous support and encouragement for students who are often reticent to learn about computers; they also allow students to experience firsthand the various successes and failures that are possible in the LAN instructional environment.

Connecting Local Area Networks and Simulations

Whether the computer configuration is a single arrangement consisting of numerous computers or an arrangement consisting of multiple pods or clusters of computers, the physical structure of an LAN resembles a group (Schipke, in press-b). When interactive writing software is installed on a computer network, students can freely communicate with one another through written dialogue which facilitates not only group (cooperative) learning but also collaborative writing. Because of these social dimensions, LAN's offer numerous advantages for teacher training. They offer a way to demystify network technology for teachers and a way to help teachers learn to make more effective use of computer networks in their classrooms. Most importantly, LAN's represent a much more effective method of influencing the way that preservice teachers will teach. By training future teachers on LAN's, using an array of simulation activities, we not only teach them how to teach, we also teach them how to teach with technology. By using simulations involving practical activities, oral skills, group work, and interactive learning, we also allow future teachers to function as professionals and to learn from their mistakes.

Because simulations are operating models of physical or social situations, they have inherent social dimensions like those intrinsic in LAN's. They are events in which the participants have realistic roles and where sufficient information is provided on a problem or issue to enable the participants to function as professionals. Because there is no teacher, the simulation is, in every respect, a non-taught event. The participants must accept the responsibilities and duties associated with their professional role, including the power and authority to make mistakes (Jones, 1987). While simulations are, in every way, designed to represent reality, they in fact only provide an incomplete or partial picture. Still they offer an extremely effective bridge between theory and practice. Jones (1987, pp. 9-11) and Taylor andWalford (1978, pp. 41-46) define certain aspects of a simulation that differentiate it from other classroom events and make it an appropriate learning model in a teacher education context. In summary, these aspects include:

1. Experiential vs. programmed learning (mistakes are inevitable and desirable). Students have an opportunity to learn both collaboratively and on self-directed lines.
2. Teacher authorship vs. participant authorship (key facts must be provided, not invented by participants). The facts are a simplified abstraction of the bare essentials of the situation being studied.
3. Plausibility and consistency vs. reality replication (focus on events or people rather than materials or paper). The focus is upon explicating essential relationships in the situation and upon understanding the interplay or dynamics taking place between key roles.
4. Process (open-ended) vs. product (clear objectives) (questions are more important than answers). Students have the opportunity to feel the direct impact of the consequences of decision-making.
5. Debriefings vs. measured outcomes (time allowed for appraisal, reflection, and trying again instead of instant enlightenment). Time passes more quickly than normal so that the implications of action in these situations can be clearly and repeatedly felt.

The open-ended nature of these aspects—how they focus on the plausible, the experiential, and the evolutional—logically parallels the processes, dynamics, and possibilities that characterize relationships and events that develop and take place on local area networks. Therefore, by teaching planning and instructional skills via simulations in juxtaposition with LAN technology, we prepare teachers who not only possess content knowledge, but who are flexible, who are self-learners, and who are computer (network) literate. Not only do they learn from the experiences that you provide, they also learn from their mistakes. They learn as most teachers eventually learn in the field: how to make decisions, how to deal with ambiguity, and how to continue to learn throughout their career from both the successful and the unsuccessful events and experiences that take place in their classrooms.

Simulation Design for the Networked Learning Context

Rationale

Those preparing teachers with LAN's and simulations as a technique will need to consider notonly the operating arrangements but the design process as well. This is because an appreciation of the design factors will increase both the sensitivity and the flexibility with which the technique is used. Since designing simulations for an LAN context is a relatively new concept, it may be necessary for those preparing teachers to develop their own LAN simulations tailored to meet their specific purposes. This may be, in fact, the preferred scenario, because as Roebuck (1978) points out, simulations are less likely to "achieve their aims to the same extent as when authors/designers are in charge of the teaching" (p. 104). Very often, teachers' styles differ from one another and may not match the designer's intentions, thus hindering effective implementation of the model.

Simulation design, then, can be a valuable learning process for the teacher educator; teaching their own simulations can also promote, even guarantee, the continued development and use of simulations in teacher preparation programs. Another key factor that will play a role in the continued development and use of LAN simulations is careful documentation and research by the designer/teacher. While it will not be discussed in great detail here, it is important to note that as part of the learning process, teacher educators will need to document their design and evaluation processes thoroughly (ex. case studies, descriptive analytic studies). Such documentation will serve to illuminate both processes and procedures in simulation development and evaluation and will allow for comparison between models and for dialogue among simulation designers/teachers. These same observation and critical analytical skills will prove invaluable to the teacher educator who must evaluate or assess student progress during the simulation.

Overview of the design process

At the heart of the design process is the understanding that simulations are organized devices for arranging interactions and are ways in which learners and media interact. Many types of simulations exist, and there are probably just as many ways of designing them. The best analogy for writing a simulation is to think of it as a piece of creative writing, requiring both know-how and imagination. Through the process of design, the simulation writer creates a "fictional" world where a social process or system can be understood and learned. Here, the fictional world would include planning, teaching, and observation on an LAN. Still, while it is difficult to delineate a specific and universal process suitable for all simulation writers, experts such as Abt (1966), Boocock and Shild (1968), and Gordon (1970), who have done pioneering work in simulation design, have suggested certain concrete stages for the design process. Taylor and Walford(1978, pp.44-46) provide an excellent explanation of these stages which can be summarized as follows:

1. Problem identification—deciding upon the purpose of the simulation and specific objectives (possibly creating a scenario).
2. Context—selecting the intended environment or system to be modeled.
3. Isolation of component parts of the system—identifying and stating the key elements of the system such as institutions or groups, major variables, and decision sequences.
4. Resource manipulation—deciding upon resources (and their value) and using them seamlessly for both a) the target group (from 2 to 30 or more participants) and b) the problem situation (which has clear objectives and goals).
5. Making the model work—formulating the interaction in manageable classroom terms.
6. Finalizing the rule systems—creating adaptable rules for the simulation by finding an appropriate balance between real world and artificial rules (this includes strict and loose rules and those that can be broken).
7. Tuning the model—taking the simulation through a dry run, analyzing the problems and successes, and making the necessary adjustments.

Preparing Teachers for the Changing Public School

Before beginning the process of developing the simulation(s), it is important to note that the role of the teacher is changing and so is the institution called "school." This is best reflected in the proposed National Education Goals for the year 2000. Included among those goals is educating a literate populace whose members have learned to use their minds well and who possess the necessary knowledge and skills to compete in a global economy. For the teacher educator whose job is to prepare teachers with the appropriate skills and competencies, these goals alone represent a major challenge. It is therefore important to begin the development process by defining (and continually redefining, as necessary) the role of the teacher to meet these challenges. Public school teachers will need, for example, to be informed, flexible, well-integrated, and able to function effectively and survive in this changing system. Among the skills and competencies teachers will need to possess are:

1. an understanding of student differences (culture, ability, and background);
2. an awareness of state mandates and on-the-job demands;
3. an understanding of the nature and complexity of the task of teaching in the public school today;
4. the necessary methodological, technological, and problem-solving skills to teach in their discipline; and
5. a wide range of expertise (including reading specialist, writing instructor, remediator, computer/media specialist, psychologist, counselor, researcher, leader, facilitator, observer, etc.).

Simulations will need to address these various requirements for students to meet the demands of teaching successfully in the public school. The simulations will also need to provide adequate opportunities for students to gain firsthand experience in planning, teaching, managing, and observing in the LAN environment. Most importantly, the simulations will need to provide numerous opportunities at various junctures, and afterward, provide for critical assessment and discussion of the interactions and events that have taken place.

General Strategies for Incorporating Simulations into the Teacher Education Curriculum

There are several strategies for the structure and introduction of the microteaching simulation (or core activity) so that it dovetails with the wider learning sequence of the course. Taylor and Walford suggest, for example, that simulations can be used as an initial stimulus, as a centerpiece of a unit of work, or as a reinforcing experience (using it twice) to improve performance. The time frame and how the simulation is used, of course, will depend upon the teacher-educators' styles and the specific goals and objectives they have set for their courses. Regardless of the application, the key to the successful use of simulations in the LAN environment is their flexibility.

A Prototype Simulation

While it is not possible to present an all-encompassing simulation in this paper, it is possible to provide an overview of one way to approach an LAN microteaching

Figure 1. Sample LAN Microteaching Simulation on Giftedness.

1. **Preparatory work:**
   a. Teaching about giftedness.

2. **Briefing:**
   b. Providing the introduction and background of the "gifted" simulation.
   c. Introducing the simulation as an instructional mode (if not done in previous simulation).
   d. Handling the preliminaries: Casting roles (student and/or reading specialist, writing instructor, remediator, computer/media specialist, psychologist, counselor, researcher, leader, facilitator, observer [department chair, fellow teacher, principal]) and discussing the objectives of each of the participants in relation to the gifted theme.

3. **More preparatory work:**
   e. Overseeing an LAN dialogue session as a facilitative interventionist. A focused problem-centered role activity (or professional meeting of experts). Scenario: Teacher meets with experts to seek advice and discuss the special needs of gifted students. The transcript produced is used by the teacher as a resource for developing the teaching plans.

4. **Microteaching Simulation:**
   f. Teaching the lesson: The designated teacher is in complete charge during the LAN-based simulation. Other participants assume the roles of students, observers, and experts who can offer helpful and unique perspectives on the teaching experience. It should also be noted that the teacher educator assumes the role of a detached observer/assessor during this period.

5. **Debriefing:**
   g. Helping participants (in functional roles) to review systematically the events and outcomes of the simulation: initial perceptions of the lesson (objectives, materials, and instructional strategies); the focus and progress of the lesson (procedures, behavior, and management); the results of the lesson (learning outcomes and achievements).

6. **Follow-up:**
   h. Allowing time for discussion and feedback on the simulation itself: general reactions, ideas for improvement, suggestions for further use, possibilities for further work,etc. Video recordings can also be used for further classroom analysis or for individual conferences.

simulation. If, for example, the simulation was to be used as a centerpiece of a lesson or unit of work, and the lesson (or series of lessons) was to focus on giftedness, then the fictional world and its inhabitants would deal with the planning issues and teaching problems as they relate to this central theme. Such a simulation would follow the basic sequence of preparatory work, briefing, simulation, debriefing, and follow-up, and might look like the general model presented in Figure 1.

Implementation

For successful implementation of any LAN simulation, the teacher educator will need to lay sufficient groundwork and adequately prepare to use it. Despite thorough planning, however, it will be the combination of the human and technical resources available, the quality of the simulation, and the skills of the teacher educator that ultimately determine the success of the simulation and the learning that takes place.

Conclusion

LAN's create a "micro world," and simulations allow extensive exploration of all the various roles teachers fulfill within that technological world. Taken together, LAN's and simulations offer a holistic teaching experience in which students can encounter both successes and failures; engage in interactive teaching and learning; take on a variety of roles and responsibilities and can be independent decision-makers; acquire planning, teaching, management, and assessment skills; and where, for the period of the simulation, they can be completely human professionals.

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Computer networking and collaborative knowledge construction: The ICONS computer-assisted international negotiation project

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What Is the ICONS Project?

The International Communications and Negotiations Project (ICONS) provides teachers in this country and abroad with a way of introducing their students simultaneously to computer networking and to collaborative construction of substantive knowledge within a group of peers. This project contrasts with many current efforts in three ways: first, it uses real content from social studies and international relations (not computer games and not science topics); second, it utilizes interchange between students in a small group of at least five (not individuals or pairs); third, peer-leadership is critical in the groups (not teacher leadership alone). The project is also unique in that research and evaluation have been integral to its development.

The ICONS Project is based at the Department of Government and Politics at the University of Maryland in College Park and uses a software program developed by Jonathan Wilkenfeld. This sophisticated computer networking program allows for both electronic mail communication and on-line or real-time conferencing. The software is the central element of an educational program which focuses on the discussion of international issues by secondary school and university students.

During ICONS participation, teams of 5-12 students role-play diplomats from another country and negotiate about international issues through the use of a computer networking system. All communication withinthe team about the positions to be taken and messages to be sent takes place face-to-face. All communication between country teams takes place using the network provided by the computer system, either through electronic mail or during scheduled on-line conferences in which students can communicate simultaneously with teams representing other countries. Sometimes these teams are in adjacent rooms; sometimes they are across the country or even across the world.

In addition to the structure provided by the conferencing software, there are materials included as introduction (e.g., a scenario set in the near future which lays out the world situation with respect to issues such as human rights, the environment, and international trade) and activities in which participants engage before beginning electronic conferencing (e.g., writing a position paper about the issues of the scenario relating to the country they represent). There is a team leader (usually a college student or a teacher) whose role will be described more fully in the last section of the paper. During the on-line conferences a Simulation Coordinator and a team of graduate students representing the United States also provides structure to the experience. The Coordinator helps the students develop the agendas for the on-line conferences, makes suggestions when the messages stray too far from that agenda, and calls a vote on issues when appropriate. The program, originally developed for advanced university students, continues to serve students at that level both here and abroad. A version of this university-level simulation will be used as a general studies interdisciplinary social sciences course for freshmen and sophomores at the University of Maryland in the fall of 1993. The part of the project being described here, however, has been adapted for use with 13-17 year olds. It has been implemented for seven summers as the central activity of the Maryland Summer Center for International Studies and as part of the Pennsylvania Governor's School for International Studies. For five years there has also been an active program during the school year (September through May) in which secondary schools across the United States and in Canada participate for about 3-4 weeks of conferencing time. This activity is usually embedded in a semester-long course in history or social studies. Schools in Japan and Argentina have also participated.

How Does the ICONS Project Exemplify Current Ideas About Learning?

The project began seven years ago without much of a theoretical base but with many ideas about how to stimulate thinking in adolescents about world issues. During that seven year period, the theory regardingeffective learning and cognitive processing has caught up to the pedagogy that this project has been practicing. It is now commonly accepted that the most effective educational settings are those in which young people are stimulated to extract meaning from situations and construct knowledge for themselves. That process has been found to result from active cognitive processing or from thinking about new material and is often stimulated by prompts, questions, or structures provided to help students relate new material to what they already know. Discussion with peers and with adults is a very important part of this type of learning.

What Is the Function of the Team Group of Peers in ICONS?

Although structure for the program is provided by adult leadership and the computer network, the real cognitive work of the program takes place within the teams as students discuss and debate their positions.

The type of interchange that takes place fits into the category of socially shared cognition (Resnick, Levine, & Teasley, 1991). ICONS participants are immersed in co-constructing knowledge in the form of messages. The discussion within the teams consists of one individual beginning a sentence which another student completes. During this process, suggestions for messages and changes in messages flow fast and furiously among the participants. The discourse within the teams is often mutually shared, in that individuals interrupt each other constantly. When the message is actually sent, it is usually difficult to determine who has authored it.

The group created through this interchange also closely resembles what Lampert (1990) calls a discourse community. Lampert described exemplary elementary mathematics classrooms as places where students became participants in a discourse community of mathematicians sharing assumptions, explanations, and constraints on solutions. The analysis of extensive narrative observations suggests that the ICONS project creates a temporary but authentic discourse community of international diplomacy where participants are immersed in socially shared cognition and co-construction of knowledge.

At first, leadership is provided by the teacher who provides scaffolding by asking questions of the adolescent participants; later there is a shift to peer leadership which moves among equal participants and includes substance (how to word a message), social guidance (helping the team feel good about its progress), and metacognitive monitoring (what the team needs to consider next). This discourse community hasas its educational aim the promotion of individual change in cognitive structures in the domain of political thinking about international issues.

The particular character of these discourse communities can be illustrated by an excerpt from narrative observations conducted in 1990 of the construction of messages and their exchange over the computer network during an hour-long on-line conference. These observations document the participation structure of these groups and the way in which the processes of thinking, revising, explaining, and mutual construction took place in this discourse community. These narrative observations illustrate collaborative construction and socially shared public cognition within the teams.

The following interchange took place among participants on the French team during a 1990 on-line conference which focused on the problems of debt in Southern hemisphere nations and the economic difficulties faced by the Soviet Union.

A: Do we have to pass this through and get the opinion of the South?
B: We wrote that we would in our position paper.
C: How much does USSR want?
B: 100 billion, that's about right. We have to make sure the others know. But I think instead of a percent we should say how much. We have to make the G7 countries pay more, correct?
D: I thought future exports were to reduce the debt.
B: Like a proportion of them, they were.
Leader: What about collateralization?

D: I thought that was one of our options. Is this money going to the IMF (International Monetary Fund)?

Leader: What is Japan's position? And why are you changing your mind about percentages?

B: It should still work.

Note the several places in which the students serve as resources to each other in articulating and examining assumptions about messages they have received and those they are planning to send--the assumption that a country can't make unilateral policies without "passing it through" other countries, that to make up the required amount "G7 countries must pay more," and that loans or grants are meant to be repaid with "future exports." A student refers to the position paper as providing scaffolding for negotiation. The leader uses questions to focus attention on options not yet discussed ("collateralization"), on considering the position of other countries ("Japan"), and on thejustifications for what she perceives as "changing your mind." One of the students also gives metacognitive direction to the team's process, suggesting that team members "make sure the others know" what has been decided, while another student comments on how a policy may have changed but still relates to overall goals ("it should still work").

There is considerable evidence from these and other observations that participants in ICONS acquire practice in higher-order-thinking about social issues, in defending their positions, and in clearly stating their ideas as they debate how to phrase messages to be sent to other teams. This has been found in observations in every summer program and in programs completed during the school year at participating high schools. These dialogues are very similar to the kind of classroom discussion which has been found by many educational psychologists to contribute to students' ability to identify and solve problems by understanding the underlying principles of a field rather than by applying methods learned by rote.

What Are the Outcomes for Individuals?

In 1985 I began the evaluation and research on ICONS using the kinds of assessment common then--multiple choice tests (which showed increases) and attitude scales (which showed differences, especially in attitudes toward developing countries). But it became clear from observing the teams that the process was one of constructing meaningful knowledge, not memorizing rote facts, and so the assessment methods changed. Now we use think aloud problem solving and performance-assessment techniques which come from cognitive psychology. To give one example, students are asked to think-aloud while they solve hypothetical problems (e.g., problems concerning a finance minister in a developing country who cannot pay the interest on his debt or a diplomat who observes that a neighboring country is about to institute apartheid laws and wishes to intervene). Analysis of protocols from these think-aloud problem-solving tasks suggests that the students' expertise in political thinking ranges from pre-novice to novice to post-novice to pre-expert to expert. Interviews conducted before and after ICONS participation show individuals moving toward expertise, (see Torney-Purta, 1992).

Are the Benefits of Participation Limited to Certain Types of Students?

There was some concern that only gifted students could benefit from a project such as this, that other students would either tune out because too much wasexpected of them or that they would just "fool around" with the computers. Although we began in the summer program with gifted and talented students, we have found that ICONS participants who are not designated as gifted and who participate in an assigned class, rather than choosing to participate in the summer, appear to gain from the experience. In fact, the large majority of participants in ICONS are very attentive and demonstrate high levels of motivation. They are often "glued to the screens" awaiting responses to their initiatives from their peers on other teams.

During on-line conferences, the summer students rated themselves as being involved in some kind of task-related behavior such as discussing messages or reading what is sent from other teams approximately 80% of the time. These findings were generally corroborated by raters who viewed the video-taped sessions. On a 7-point scale on which participants rated involvement during conferences (1 indicated "bored" and 7 indicated "interested"), the mean rating was 5.61; no student chose a 1.

Recently a teacher in the semester program described the following:

> I could see the boredom begin to show (before the conferencing phase began). As the first conference began I watched the expressions on their faces. They were totally engrossed and involved. They left with an enthusiasm that I can't begin to describe.

Some teachers also expressed concern that boys might participate more and thus would gain more from ICONS than would girls. There appears to be some variation by year and by group in gender differences. Analysis of video-tapes from one year showed that although boys took the lead at first in some groups, by the end of the sessions, girls were as assertive as boys. Analysis of another year's tapes and self-report questionnaires showed that female students appeared especially skilled at making sure the group made progress toward its goals by commenting on or monitoring how the group was working together, or by making sure all points of view were heard. Particularly in the past two years, female participants have indicated that they are in every way as well qualified as males for careers in international relations and international business. In summary, the gender differences are subtle and relate to the style rather than amount of participation. Also gender did not seem to relate to any cognitive changes that occurred in the students.

What Has Been Learned About Technology and Motivation?

Several characteristics of this program seem especiallyimportant in promoting change in cognitive structures and in producing the high levels of student involvement that were observed.

First, the computer screen is an object of highly focused student attention because it is constantly changing and providing valued information in a way the blackboard or textbook does not. This characteristic appears to enhance student information processing. For example, one student enters a proposed message which then becomes visible to all team members. The process of co-construction and group revision of the message on the screen provides a potent stimulus for elaborating individuals' representations and for facilitating students' discovery that what seems obvious to one about a situation or solution may not be obvious to another. Often participants suddenly recognize complications even in a simple proposal.

Second, participants are referencing to the opinions of their peers. Like situations involving collaborative problem solving, participants are pressed to arrive at an agreed-upon solution (message). Unlike much collaborative problem solving, there is no way of designating correct solutions; this seems to lead students to search for their own judgment criteria to satisfy themselves and their peers. Often teams express concern that a message they had sent allowed teams from other countries to take advantage of them. These perceived "errors" are used as the source for after-conference discussions in which the leaders help to identify possible repair processes for the next conference.

Third, the existence of the messages in a printed form, as well as repeated pressure to state their opinion as diplomats representing a country, promotes ownership of ideas among team members. They realize the importance of saying clearly what they mean. This contrasts with programs like the Model UN where between-team communication takes place orally and there is often one person making statements for the country. In the ICONS project, the team can never argue, "we really didn't say that." The print-out also allows participants to refer back to a previous message, making cognitive connections between past, present and future positions.

Fourth, continually stating positions as "Nigeria believes" or "France concludes" increases identification with another perspective. On the last day, a participant said sadly, "it's really too bad; next week there won't be any messages for us as Nigerian diplomats. We'll have to go back to just being students." In one survey 90% of the participants reported high or moderate levels of identification with the country they represented.

Fifth, because the conferences take place in real time (not through delayed electronic mail), there is a senseof urgency to make points in a message clearly and quickly. If a team gets stuck revising a message, there will be 20 new messages once they return to the receiving mode.

Sixth, the team can designate that a given message be sent to all other teams of participating countries or only to selected countries--for example, allies or countries from whom one is trying to get concessions. This feature promotes an awareness in students of the difference in representations of world problems, especially between developed and developing nations.

How Are Teachers Prepared To Create Discourse Communities of Students?

It is most important that the teacher makes an effort to involve students actively in processing the material that comes to them over the network. This means questioning them about their positions, demonstrating high expectations for them, encouraging attention to the screen and to the progress of the agenda during conferences, pointing out when unclear messages have created difficulties, and debriefing the team about its goals and how they have been achieved after each conference concludes. Providing training in leadership in this program for teachers is particularly important in schools where students lack background knowledge in geography and international relations, and where they seldom read the newspaper. The most effective teachers are the ones who are constantly helping students to think about what they are doing--questioning them, asking whether they have thought about alternatives, asking them to examine assumptions.

The logistics of preparing teachers as leaders for teams remains a challenge for the project. A careful program of leader training has been developed for the summer when all teams are in the same location. The project is currently working on ways for using the network to deliver training materials and suggestions both for the period before the on-line communication begins and for the conferencing period itself. These materials will supplement the meetings which can sometimes be arranged for teachers at some distance from project coordination.

How Can Teachers Assess Students' Learning in Projects like These?

Teachers should be aware that the learning outcomes achieved by students participating in projects like ICONS include an awareness of more imaginative ways of dealing with international issues like the environment or economic development and an appreciation of the complexity in what might be called the "mental map" of problems in the world. Students do expand theirvocabularies with terms such as loan guarantees, deforestation, and CO_2. But far better than a vocabulary test for assessing student learning is for teachers to ask their students to write about ways to deal with international problems, about things that stand in the way of countries reaching agreement, about connections they see between economics and politics or diplomacy. Some of the newer approaches to assessment such as portfolios, performances or projects and concept maps are also excellent tools for assessing thinking in the social studies in a project such as this. One of our very creative teachers asked ICONS participants at the end of the semester to write a paper giving advice to students who would participate during the following semester--what should they avoid in their negotiations, what sources should they consult. These papers proved to be a very interesting assessment method.

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Communication, simulation, and chaos

Dora Perry-Wilson

Introduction

The fact that patterns, codes and structures form a basis for communication is not new. Even the idea that the same notation can be used for a sonnet, a masterpiece or graffiti is not new. Nor is the fact that microbes have controlled our destiny, yet all of these have communication linkages for systems design. The complexity of molecular interactions and the sophistication of their evolutionary experiments present us with an awesome and wondrous assemblage. This vast, and as yet largely unknown, biological entity is millions of times more ancient and perhaps more advanced than we.

> A living system appears very complex from the thermodynamic point of view. Certain reactions are close to equilibrium, and others are not. Not everything in a living system is "alive." The energy flow that crosses it somewhat resembles the flow of a river that generally moves smoothly but that from time to time tables down a waterfall, which liberates part of the energy it contains. (Prigogine & Stengers, 1984, pp. 155-156)

This linkage, which indicates order emerging from the chaos, has interdisciplinary applications wherein even artificial intelligence is compared and contrasted with molecular biology. With the advent of electronic imagery, mark-making skills have developed into an impressive range. From crayon marks placed on whitehallway walls or hands shoved into a lump of clay to messages transmitted by nucleotides within DNA or digital imaging and pseudo-color applications—all these are merely marks, equally significant and powerful. Astronomers at Los Alamos National Laboratory have used a computer to explain visually the behavior of Hercules x-1, a special binary star system. They produced a simulation of the tilted gas disk *not* to research their theory, but to communicate it visually.

Symbolic Language

Visualizing is the artist's means of thinking aloud to search out the image to best communicate an idea. Like an airbrush or a pen, electronic imagery is merely using a device, with its own strengths and weaknesses. However, this new metamedium has degrees of freedom for representation and expression never before encountered and as yet, barely investigated.

According to Harold Cohen, a 1960's established contemporary artist, art compels us to interpret marks. If the artwork represents elements with which we are familiar, i.e., trees, flowers, mountains, etc., we identify them as such. More important, Cohen believes, are the basic image-making and image-reading programs that link the artist and the viewer in the transaction we call art (Johnson, 1986). The result? In 1974, Cohen began a program for a Digital VAX computer which, over several years, grew into a short novel entitled, *Aaron*.

In 1983, *Aaron*, now known as the artificially intelligent artist, had a show of works exhibited at the Tate Gallery. Responding to the continual randomized or preprogrammed question, Cohen says:

> Why just two mutually exclusive options? We know perfectly well that, for human beings, there is a space between totally deterministic behavior and totally chaotic behavior. It is the space of intelligence. . . . The laws of logic are what they are, and it doesn't matter who—or what—applied them. (Hughes, 1984, pp. 597-598).

Harold Cohen, artist and programmer, views art as a universal celebration of the human mind. Allan Kay has focused it in the following: "Some people worry that artificial intelligence will make us feel inferior, but then anybody in his right mind should have an inferiority complex every time he looks at a flower" (Caddes, 1986, p. 76). This complex interweaving can manifest itself in the key criteria for artificialintelligence: Fear or use will designate it as wings or chains.

Our video is a visual attempt to give it wings. The cocoon threads are interwoven by a desire to communicate, and the emerged butterfly has wings to soar above the limitations of a specific discipline. There is a metaphor within this visual exploration: The butterfly symbolizes the spirituality needed to transcend our egos and personalities which often cause us to want to intellectualize, categorize and therefore predict.

Native Americans have always fused art and science visually into their healing and religious ceremonies. Navajo artist Alvin Marshall says of his sculpture *Journey Into the Butterfly World*:

> Everything is here for a reason. . . . We must walk in sacredness with the Great Spirit; he gives us everything on earth. I'm grateful for the talent he has given me and grateful that the stone, the animal and I can touch your heart. (Jacka & Jacka 1988, p. 141)

Strange Loops For Education

"The basic mechanism through which molecular biology explains the transmission and exploitation of genetic information is itself a feedback loop, a 'nonlinear' mechanism" (Prigogine & Stengers, 1984, p. 154). A dissipative structure introduces one of the simplest physical mechanisms for communication. The structural environment of nonlinear, self-organization science is used to design Strange Learning Loops. Visual technology is the linking catalyst for the "jumping out" process.

Strange Learning Loops are dissipative structures—NOT lesson plans, unit plans or predictable behavior patterns. They evolve thus, yet connect: It is a mixture of chance and necessity that constitutes a system of bifurcations, which may be unstable, but become stable. The participants unite and provide the needed stability as they work with a common theme. The system behaves as a whole, as if it were a unit responding to long-range forces or a "strange attractor." The strange attractor in the loop promotes interaction among participants in much the same way as it does among molecules. The main theme is the objective, which pulls the bifurcations together and structures a system wherein each participant is always in communication, thus informed about the overall state of the system. A loop is always unique, since each theme and each bifurcation is developed in response to a challenge. An entire loop can take place within onemind or within a group of participants.

Douglas Hofstadter's Theory of Strange Loops, a Tangled Hierarchy of Levels (Hofstadter, 1979), may well parallel the artist's quest for order while basking in the stimulation of chaos. Strange Loops make use both of the subjective and of the objective, especially in the arts where the creative process thrives on chaos.

Currently there is a switch in the paradigm for structuring the learning process at all levels and in different environments. The old one was mechanistic and predictable: a cause and effect approach. The emerging new paradigm may be called "holistic," emphasizing global concerns: a challenge and response approach. For children, Strange Learning Loops are that nonlinear curiosity which leads from one topic to another, yet connects to its point of departure. This "Grasshopper Mentality" will be even more comfortable five years from now when we have solar-powered computers. Just like nonlinear, self-organization cience with resulting chemical clocks of molecular communication, all students share results to provide the needed infrastructure of an Open System design. Curriculum organizes itself by dissipating its disorderly entropy—unpredictable changes or bifurcations become motivation for investigation. Human beings are unpredictable, yet life organizes itself—thus the need for interdisciplinary curriculum design. Three examples follow; the first "strange attractor," or theme, is energy.

In Figure 1 the ecosystems loop illustrates the open-ended design of such far-reaching elements as "patterns" and "time."

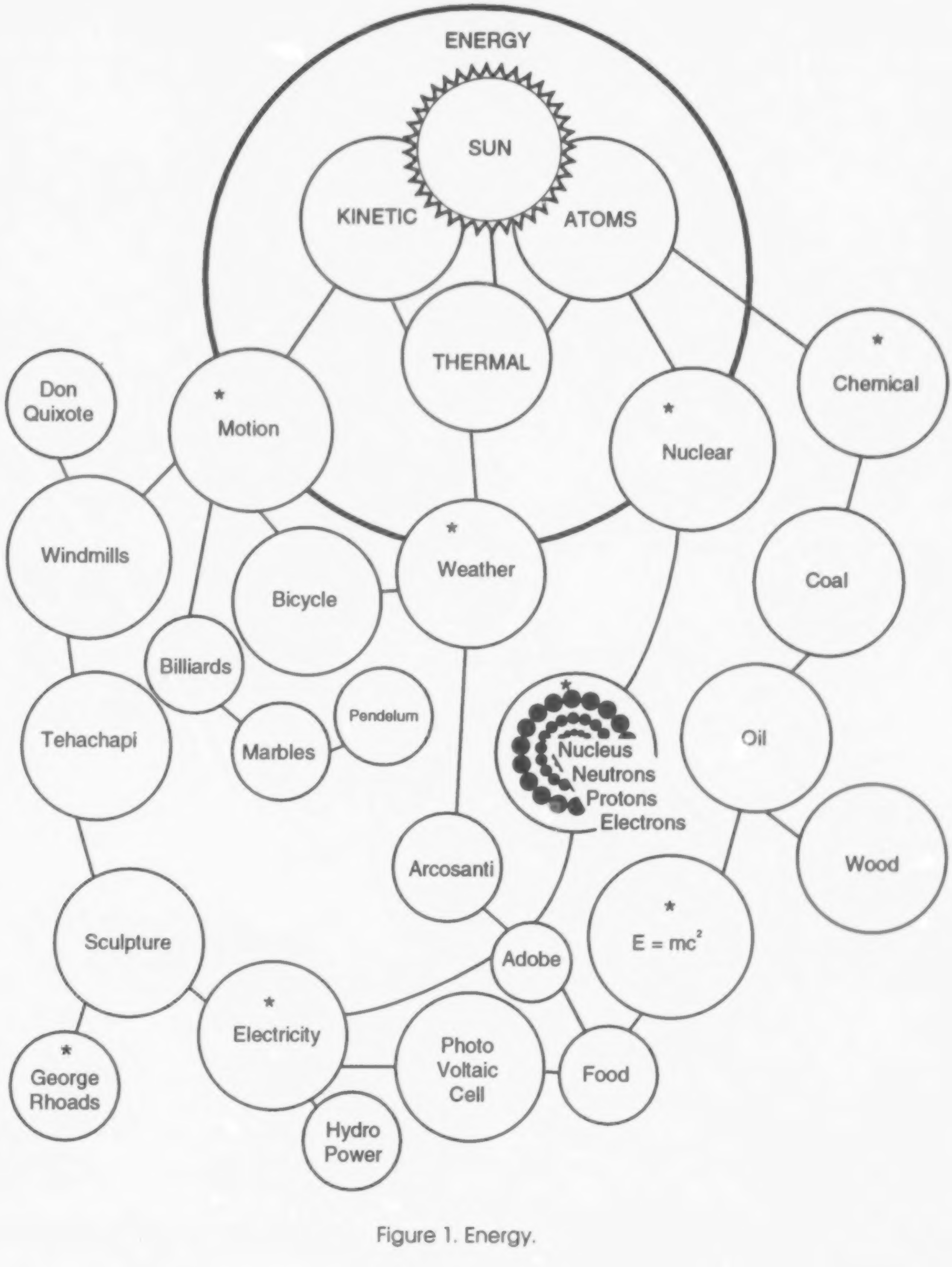
ENERGY
SUN
KINETIC
ATOMS
THERMAL
Don Quixote
*
Motion
*
Nuclear
*
Chemical
Windmills
*
Weather
Bicycle
Coal
Billiards
Pendelum
Tehachapi
Marbles
*
Nucleus
Neutrons
Protons
Electrons
Oil
Wood
Arcosanti
*
$E = mc^2$
Sculpture
Adobe
*
Electricity
Photo Voltaic Cell
Food
*
George Rhoads
Hydro Power

Figure 1. Energy.

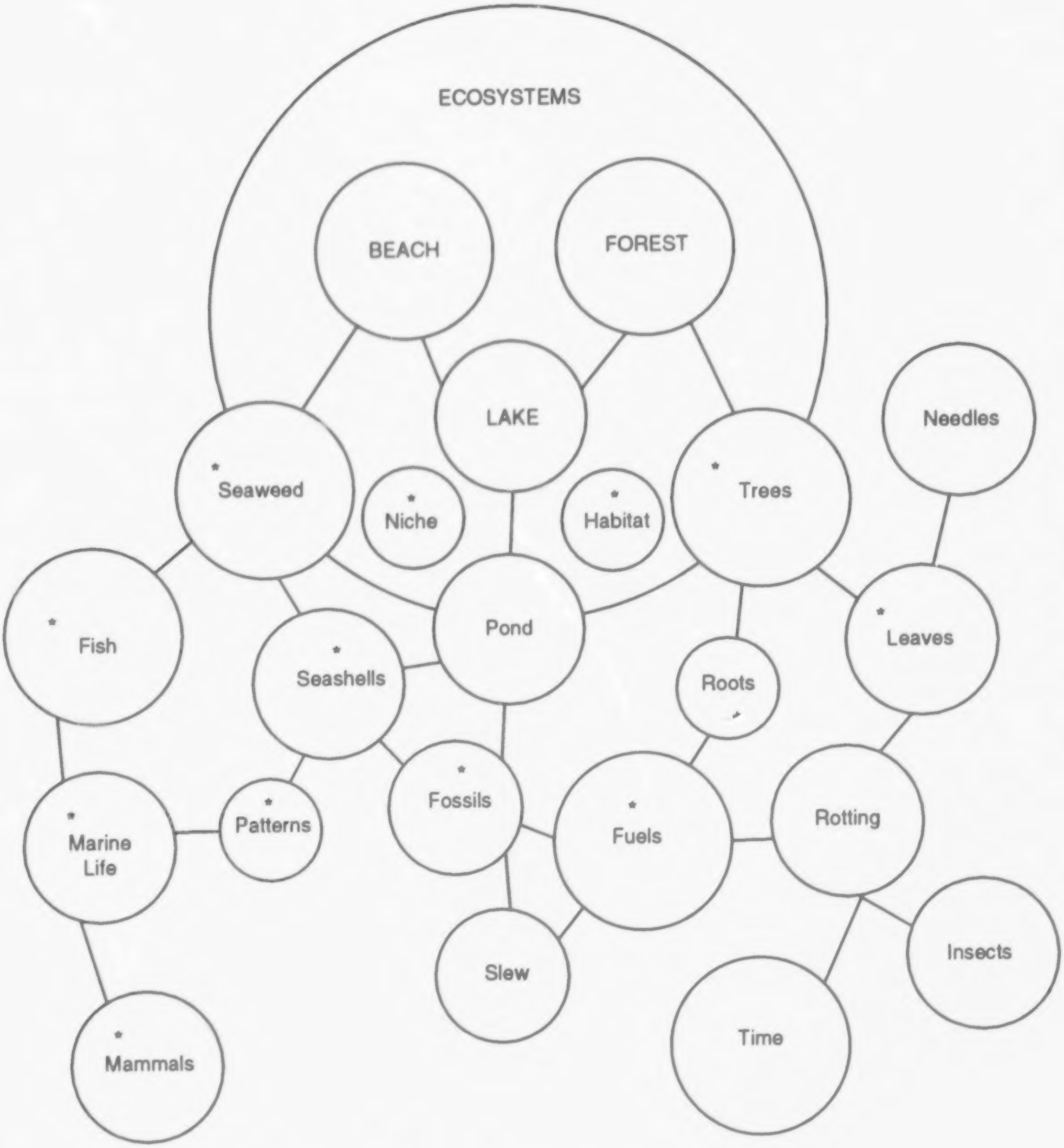
ECOSYSTEMS
BEACH
FOREST
LAKE
Needles
* Seaweed
* Niche
* Habitat
* Trees
* Fish
Pond
* Leaves
* Seashells
Roots
* Fossils
* Fuels
Rotting
* Marine Life
* Patterns
Insects
Slew
Time
* Mammals

Figure 2. Ecosystems.

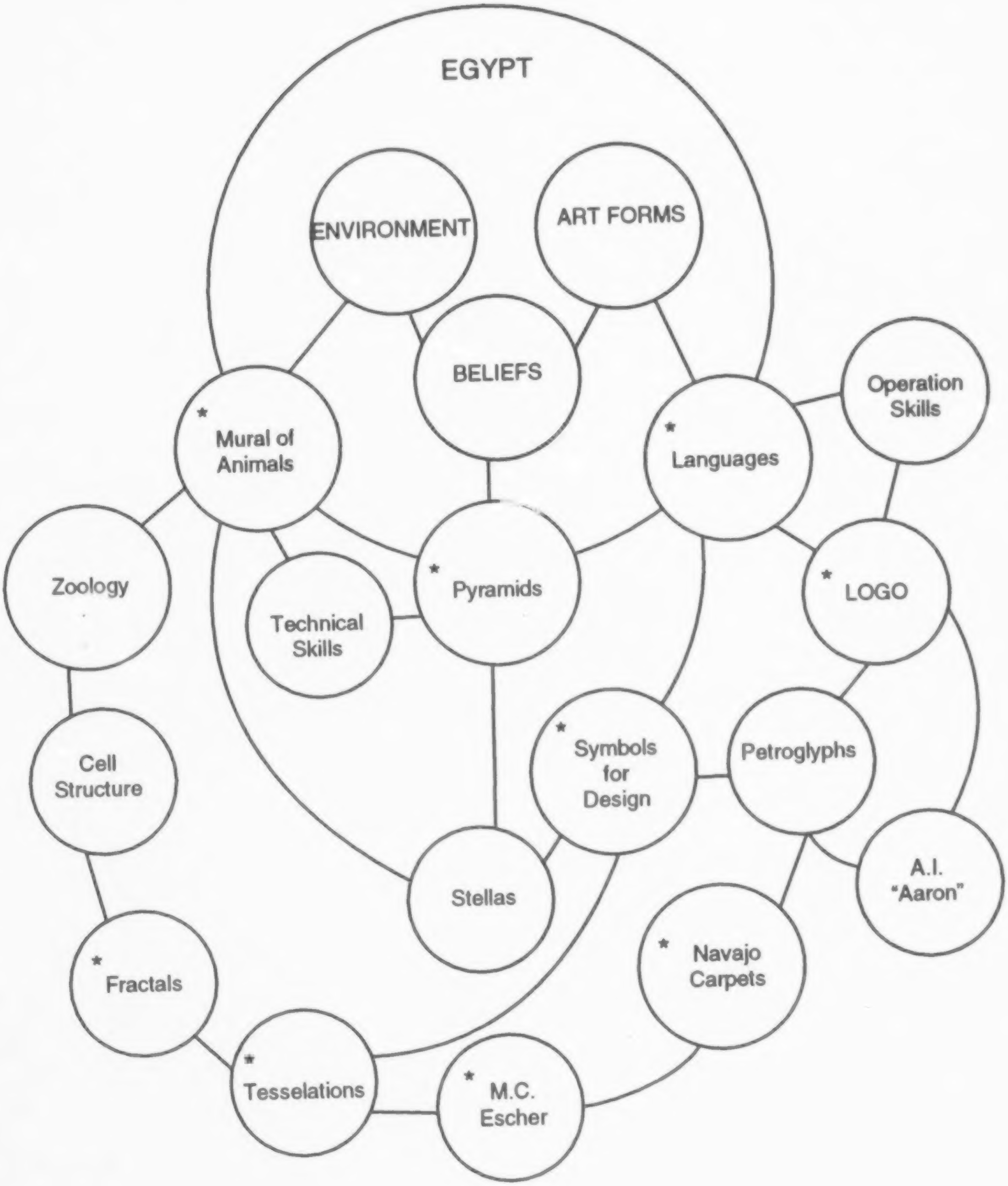
EGYPT
ENVIRONMENT
ART FORMS
BELIEFS
Operation Skills
* Mural of Animals
* Languages
Zoology
Technical Skills
* Pyramids
* LOGO
Cell Structure
* Symbols for Design
Petroglyphs
Stellas
A.I. "Aaron"
* Fractals
* Navajo Carpets
* Tesselations
* M.C. Escher

Figure 3. Egypt.

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AUTHOR LIST

Abate, Ronald J. 300
Al-Sharhan, Jamal 423
Alexander, Bill 200
Anderson, Larry S. 646
Anderson, Mary 675, 153
Anderson, Susan E. 564
Armitage, Deirdre 19
Austin, Maggie 711
Bahr, Christine M. 60
Bao , Julie Q. 147
Barron, Ann E. 476, 536, 648
Bauder, Deborah 482, 560
Bauer, Jeffrey W. 125
Baumbach, Donna J. 103
Beach, Bonnie 707
Bednar, Maryanne R. 196
Benavides, Otto E. 28
Bennett, Christene K. 273
Bievenue, Lisa 637
Bird, Mary 103
Blanton, William E. 696, 700, 703
Bogart, Jim 440
Bohlin , Roy M. 28, 488
Bohlin, Carol Fry 28
Braswell, Ray 159
Brent , Rebecca 143
Brewer, Sally 103
Bright, George W. 573, 590, 624
Brown, Gary R. 264
Brown, Jennifer 159
Brownell , Gregg 136
Brownell , Nancy 136
Brush, Thomas 716
Bull, Glen L. 632
Byrum, David C. 336
Cafolla, Ralph 313, 425, 468, 570
Carr, David 560
Casey, Patrick J. 78
Chancey, M. R. 554
Chisholm, Inés Márquez 395
Clark, Kenneth 44, 122
Connell, Michael L. 345, 443, 579
Copley, Juanita V. 51, 69, 341
Davis, Niki 693
de Neuilly Rice, Lorenzo 44
Diem, Richard A. 411
Drazdowski, Thomas A. 381
Duban, John 637
Dubenezic, Charles W. 350
Edyburn , Dave L. 113
Enneking, Marjorie 327
Eskridge, Susan W. 661, 667
Fabris, Marta 414
Farmer, Charles 637
Ferris, Angeline 88
Fleener, M. Jayne 596
Flemister, Michael G. 707
Fontaine, Anne 610
Ford, Mary Jane 41, 610
Foster, Tim 74
French, Michael P. 117
Fulton, Kathleen 1
Galloway, Jerry P. 430
Gamble, Linda 414
Gartmann, Shirley 251
Grandgenett, Neal 55
Haines, Leonard 234
Hall, Robert T., Jr. 613
Haney, Michael 327
Hannaford, Alonzo E. 60
Hannah, C. Lynne 300
Harlow, Steven 361
Harris, Judith B. 641
Hawk, Tom 440
Hayes, Caroline 680
Hess, Robert K. 357
Hoadley, Diane B. 239
Hoadley, Michael R. 239
Hosticka, Alice 44
Howard, Dale C. P. 389
Howard, Peggy Ann 389
Howard, Vikki 153
Huang, Shwu-Yong L. ..69, 514, 519, 524, 531
Hunt, Nancy P. 25, 488
Ivers, Karen S. 476, 648
Jackson, Sue 41
Jafari, Ali 162
Javetz, Esther 166
Johnson, LaMont 361
Kauffman, Dan ...313, 425, 468, 570
Kenney, Stephanie L. 60
Kepner, Henry S., Jr. 600
Kerney, Carol A. 173, 178
Kinzie, Mable 632
Knapczyk, Dennis 716
Knott, Tara 725
Knupp, Blaine E. 472
Kolloff, MaryAnn 289
Kolvoord, R. 107
Koppelman, Jan 133
Kupsh, Joyce 230
Landretti, Ann Polzer 117
Langer, Margaret A. 667
Lee, Judy 249
Levin, James 187
Liao, Yuen-kuang Cliff 498
Linek, Wayne M. 506

Logan, Jerry 264
Lotfipour, Shahnaz 434
Love, William P. 590
Lowe, Mary Ella 672
Luna, Gaye 74
Mach, Nada L. 224
Maddux, Cleborne D. 212
Makurat, Phillip 587
McEneaney, John E. 506
McKenna, Michael C. 122
McKenzie, Barbara K. 318
McPherson, Sarah 583
Mergendoller, John 542
Merideth, Eunice M. 434
Meyer, John 354
Miller, Robert 99
Mitchell , Tony 219
Mitchell, Janice 531
Moore, Sara D. 730
Mortenson, Robert 55
Mullick , Rosemary J. 482
Munson, Dorie E. 296, 675
Murphy, Tim 414
Nemeth, Edward J. 654
Niederhauser, Dale 542
Norton, Priscilla 448
Nulman, Dennis Michael 32
Owens, Emiel W. 528
Padron, Yolanda N. 511
Paprzycki, Marcin 219
Parker, Randall 96
Parsons , A. Sandy 399
Perry, John F. 646
Perry-Wilson, Dora 745
Persichitte, Kay A. 464
Petrakis, Elizabeth 491
Petty, James A. 613
Picciano, Anthony G. 36
Planow, Mary 560
Poage, Julie A. 296, 675
Powell, Richard R. 321
Price, Jerry 414
Pritchard, Robert H. 25
Proctor, L.F.(Len) 244
Ramquist , Raymond 286
Reehm, Sue P. 289
Regenstein, Carrie E. 305
Ritchie, Donn 182, 268
Roberts, Nancy 88
Robertson, Gladene 234
Robinson, Brent 9, 363
Roblyer, M. D. 536
Rodes, Paul 716
Rush, Michael J. 684
Ryan, Francis J. 196
Saba, Farhad 721
Sabelli, Nora 327
Sanche, Robert 234
Sarner, Ron 560
Schipke, Rae C. 735
Schmidt, Denise 130, 292
Schmidt, Ken 646
Schneiderman, Bette E. 83
Schrum, Lynne M. 550
Schulz, Cynthia D. 453
Sexton, Colleen 707
Shnay, Penny Lee 354
Shoaf-Grubbs, Mary Margaret ... 618
Sigmon, Tim 632
Skeele, Rosemary W. 14
Slaughter, Bernadette Cole 472
Smith, Edwin R. 659
Smith, Kathryn A. 65
Smith, Michael K. 283
Smith, R. Michael 386
Smith, Terry R. 65
Soon, Yee Ping 506
Sprague, Constance 506
Sridhar, Mythili 187
Stapleton, Clinton E. 688
Stoddart, Trish 542
Stollenwerk, Matt 182
Strang, Harold R. 730
Strudler, Neal B. 321
Swartz, John 193
Sweeder, John J. 196
Talab, Rosemary 440
Tellez, Kip 99
Tellez, Kip 459
Thompson , Ann 130, 292, 680
Thompson, Max S. 696, 700
Todd, Nancy I. 92
Topp, Neal 130, 292
Torney-Purta, Judith 740
Troutman, Andria P. 554
Tutolo, Daniel J. 117
Vess, Ron 200
Viau. Elizabeth Anne 258
Wardlaw, Roosevelt 308
Watkins, John 206
Waxman, Hersholt C. ..69, 519, 524, 531, 573
Westhoff, Guy M. 125
Wetzel, Keith 407
Whelan, Carol Scott 610
White, James A. 554
Wiburg, Karin 268
Williams, Susan E. 51, 69, 531
Willis, Jerry 414, 632
Wilson, Charles 283
Woodrow, Janice E. J. 368, 605
Wright, Lily 414
Wright, Peter 374
Yan, Wenfan 675
Yopp, Martha C. 279
Zambo, Ron 403
Zimmerman, Sara Olin 703
Zink, Frances 41
Zirkler, Dieter 136

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ISBN 1-880094-05-3